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AMERICAN STATISTICAL ASSOCIATION

CONTENTS *for* DECEMBER 1943

An Appraisal of the U. S. Bureau of Labor Statistics Cost of Living Index
A Special Committee of the American Statistical Association 387

Housing Scales for Rural Pennsylvania *Howard R. Cottam* 406

Coordinating Production for War *Shelby Cullom Davis* 417

Statistics for Wage Stabilization *Robert J. Myers and Harry Ober* 425

The Distribution of Deposits and Currency in the United States, 1929-1939
Solomon Shapiro 438

Variations in Expenditures where Families of Wage Earners and Clerical Workers are Classified by Economic Level *Roy C. Cave* 445

Fitting Polynomial Trends to Seasonal Data by the Method of Least Squares
Howard L. Jones 453

A Method for Determining the Significance of a Shortage *Lila F. Knudsen* 466

Paul T. Cherington, 1876-1943 *Willard L. Thorp* 471

Book Reviews 473

VOLUME 38 NUMBER 224

American Statistical Association

Organized November 27, 1839
Incorporated 1841

The American Statistical Association is a scientific and educational organization. Its membership is not confined to professional statisticians but includes economists, business executives, research directors, government officials, university professors, and other persons who are seriously interested in the application of statistical methods to practical problems, in the development of more useful methods, and in the improvement of basic statistical data. Engineers, mathematicians, biologists, actuaries, sociologists, psychologists, and representatives of many other professions are included in the membership of the Association. Information about the Association and membership application forms may be secured from the Secretary, Lester S. Kellogg, 1603 K Street, N. W., Washington 6, D. C.

War conditions have necessitated the indefinite postponement of the 104th Annual Meeting of the American Statistical Association which was to have been held in Cleveland, Ohio, December 29 to 31, 1942.

Chapters of the Association have been organized in important cities in the United States and in Havana, Cuba. Information concerning the meetings of these Chapters may be secured from the District Representatives listed on another page.

The Editors welcome the submission of articles and notes for possible publication in the JOURNAL. Manuscripts should be sent to the Editor, Journal of the American Statistical Association, 1603 K Street, N. W., Washington 6, D. C. Books for review should be sent to the Review Editor, Glenn E. McLaughlin, 1603 K Street, N. W., Washington 6, D. C. Authors who wish suggestions about the preparation of manuscripts and charts or information about editorial policies should address their inquiries to the Editor.

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CONTENTS

ARTICLES

An Appraisal of the U. S. Bureau of Labor Statistics Cost of Living Index — A SPECIAL COMMITTEE OF THE AMERICAN STATISTICAL ASSOCIATION 387

Housing Scales for Rural Pennsylvania . . . HOWARD R. COTTAM 406

Coordinating Production for War . . . . . SHELBY CULLOM DAVIS 417

Statistics for Wage Stabilization . ROBERT J. MYERS AND HARRY OBER 425

The Distribution of Deposits and Currency in the United States, 1929–1939 . . . . . SOLOMON SHAPIRO 438

Variations in Expenditures where Families of Wage Earners and Clerical Workers are Classified by Economic Level . . . . ROY C. CAVE 445

Fitting Polynomial Trends to Seasonal Data by the Method of Least Squares . . . . . HOWARD L. JONES 453

A Method for Determining the Significance of a Shortage . . . . . LILA F. KNUDSEN 466

Paul T. Cherington, 1876–1943 . . . . . WILLARD L. THORP 471

BOOK REVIEWS

BARGER, HAROLD, AND LANDSBERG, HANS H. *American Agriculture, 1899–1939: A Study of Output, Employment and Productivity.* Mordecai Ezekiel 484

BERRY, THOMAS SENIOR. *Western Prices before 1861, A Study of the Cincinnati Market.* Ernest W. Williams, Jr. 485

BOWLEY, A. L. (Editor). *Studies in the National Income, 1924–1938.* Milton Gilbert 473

BUTTERBAUGH, GRANT I. *The Measurement of Business Activity in the Puget Sound Area.* Bervard Nichols 483

CRUM, WILLIAM L., FENNELLY, JOHN F., AND SELTZER, LAWRENCE H. *Fiscal Planning for Total War.* Alfred G. Buehler 479

FABRICANT, SOLOMON. *Employment in Manufacturing, 1899–1939.* Daniel Creamer 481

FENNELLY, JOHN F., see Crum, William L.

HEANEY, NORMAN S. *Public Trusteeship.* C. Herman Pritchett 487

JACOBY, NEIL H., see Saulnier, Raymond J.

LANDSBERG, HANS H., see Barger, Harold

MAGILL, ROSWELL. *The Impact of Federal Taxes.* Richard A. Musgrave . 476

Continued on next page

REVIEWS—*Continued*

NATIONAL BUREAU OF ECONOMIC RESEARCH, Conference on Research in Income and Wealth. *Income Size Distributions in the United States, Part I.* Daniel Creamer 475

ROSTAS, L., see SHIRRAS, G. FINDLAY

SAULNIER, RAYMOND J., AND JACOBY, NEIL H. *Accounts Receivable Financing.* Robert D. Ayars 480

SELTZER, LAWRENCE H., see CRUM, WILLIAM L.

SHIRRAS, G. FINDLAY, AND ROSTAS, L. *The Burden of British Taxation.* Tipton R. Snavely 478

STURMTHAL, ADOLF. *The Tragedy of European Labor, 1918–1939.* Robert I. Crane 488

TAX INSTITUTE. *Tax Yields: 1941.* Henry S. Bloch 477

TOMASEVICH, JOZO. *International Agreements on Conservation of Marine Resources.* Reginald H. Fiedler 486

WALKER, HELEN M. *Elementary Statistical Methods.* Laverne K. Burke . 489

WILKS, S. S. *Mathematical Statistics.* Abraham Wald 491

ZAPOLEON, MARGUERITE W. *Community Occupational Surveys.* Harold F. Clark 490

PUBLICATIONS RECEIVED 493

JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

Number 224 DECEMBER, 1943 *Volume 38*

AN APPRAISAL OF THE U. S. BUREAU OF LABOR STATISTICS COST OF LIVING INDEX*

BY A SPECIAL COMMITTEE† OF THE AMERICAN STATISTICAL ASSOCIATION

FOREWORD

THE COST OF LIVING INDEX published by the Bureau of Labor Statistics has been one of the important statistical tools of the country for a quarter of a century. Designed to measure changes in the prices paid for goods and services by city consumers of moderate income, it is widely used by statisticians, economists and government officials. It has often been an important factor in wage negotiations, and has served to throw light upon the effects of fiscal and other govern-

* A supplementary report, referred to as the Appendix in this general summary, will appear in print later. This supplementary report will present the statistical evidence which the committee has assembled, together with the committee's technical recommendations.

† The committee consisted of the following members:

Frederick C. Mills, *chairman*, Professor of Economics and Statistics at Columbia University and a Director of the National Bureau of Economic Research; former President of the American Statistical Association and of the American Economic Association; author of *The Behavior of Prices*, *Economic Tendencies in the United States*, and *Prices in Recession and Recovery;*

E. Wight Bakke, Professor of Economics at Yale University; Hearing Officer, representing the public on national cases for the War Labor Board; author of *The Unemployed Man*, and *Citizens Without Work;*

Reavis Cox, Professor of Marketing, at the University of Pennsylvania (on leave); Director of Research Projects for the Retail Credit Institute of America; Editor-in-Chief of the *Journal of Marketing;* author of *Competition in the American Tobacco Industry*, and *Marketing of Textiles;*

Margaret G. Reid, Professor of Economics, at Iowa State College; author of *Economics of Household Production*, *Consumers and the Market*, and *Food for People;*

Theodore W. Schultz, Professor of Economics at the University of Chicago, and Consultant to the Board of Governors of the Federal Reserve System; author of *Vanishing Farm Markets and Our World Trade*, and *Farm Prices for Food Production;*

Samuel Stratton, President of Middlebury College; co-author of *The Economics of the Iron and Steel Industry; Problems in Corporation Finance*, and *Financial Instruments and Institutions.*

Appointed by the committee to serve as its technical staff were the following:

Dorothy S. Brady, Senior Statistician, Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture; author of miscellaneous articles and reports particularly in the field of family income and expenditure;

Solomon Fabricant, member of the research staff of the National Bureau of Economic Research; Head Economic Analyst, War Production Board; author of *Capital Consumption and Adjustment* and *Employment in Manufacture.*

mental policies. In technical statistical work it serves as a "deflator" to be used in computing "real" income and expenditures.

As wartime strains and distortions have spread through the American economy, criticisms of the index have developed. In particular, its use as a guide in wage adjustments has been widely questioned. Many critics express doubt of its accuracy as a measure of the extent to which the country has experienced inflation under the stimulus of huge governmental expenditures. Much of what these critics say takes the form of declarations that the index does not provide an accurate measure of what is happening to consumers' expenditures.

This loss of confidence in a basic and generally accepted statistical measure has occasioned much concern in professional and governmental circles. Accordingly, Dr. E. A. Goldenweiser, President of the American Statistical Association, at the request of the Bureau of Labor Statistics, transmitted through the Secretary of Labor, appointed this committee to review and appraise the cost of living index with reference both to its construction and to its uses. Having named the committee, he left it completely free and independent to pursue its investigations in such directions as seemed appropriate to it.

In our review we have canvassed interested labor organizations, employers' associations, and consumer groups. Evidence on changes in living costs has been submitted to us by representatives of these groups and by governmental agencies. Special field studies have been initiated by the committee and conducted by agents of the Bureau of Labor Statistics under the supervision of committee representatives.

The evidence we have assembled, detailed explanations of our findings and certain technical recommendations will be given in a supplementary report. We here present our conclusions in a condensed general summary followed by our answers to questions that pose the major issues.

GENERAL SUMMARY OF CONCLUSIONS

The principal conclusions to which we have come are: First, that within the limitations established for it, the cost of living index provides a trustworthy measure of changes in the prices paid by consumers for goods and services. Second, that many of the difficulties and doubts which have arisen concerning the index have their origins in attempts to use it uncritically for purposes to which it is not adapted.

The phrase "cost of living" is ambiguous. Some of the difficulties the use of this index raises grow out of this fact. In every-day speech families are apt to think of their cost of living as the total amount they spend for consumer goods and services. Several different factors may

cause such expenditures to change. Thus, they may change because the unit prices of goods and services rise or fall. Again, they may change because families are forced by circumstances beyond their control to alter their manner of living, as when the exigencies of war make some goods unavailable. Yet again, they may change because families have experienced an increase in income and can afford to buy more goods or better goods.

Changes caused by alterations in manner of living and in income have been particularly important during the war. This is true because of the very great migrations of labor and shifts in occupation characteristic of the period. Because of shifts from lower to higher-paid jobs, rises in wage rates and extension of the work week, many individual and family incomes have advanced more rapidly than living costs. Studies by the Department of Commerce indicate that the annual average compensation of wage earners and salaried workers in private non-agricultural industries increased 37 per cent between 1939 and 1942 (from $1268 to $1733). Living costs, as measured by the Bureau of Labor Statistics index, increased 17 per cent in the same period.

As used in technical statistical parlance, the term "cost of living" has applied only to the first of the factors which determine family expenditures, that is, to unit prices. The cost of living index has undertaken to measure only this one factor. Any use made of the index must keep this limitation in mind. Many of the difficulties which critics of the index have encountered arise from forgetting that it is designed to measure only changes in retail prices and trying to use it for purposes to which it is not suited unless it is supplemented by a number of additional statistical measures.

After a careful investigation of the relevant evidence we believe that the index records with a satisfactory degree of accuracy what has happened to unit prices paid for consumers' goods by city families of moderate income.

We have been much impressed during our investigation by the integrity, alertness, intelligence and technical competence of the Bureau's staff. We feel that, on the whole, working under very trying circumstances, they are doing an excellent job of carrying out the task assigned to them.

MAJOR ISSUES BEFORE THE COMMITTEE

1. *Are the prices reported to the Bureau those actually paid by customers of reporting retail stores?*

The Bureau obtains its prices through field agents who interview the owners or managers of the stores they visit. They do not actually

purchase the merchandise they price. Prices for chain stores are obtained, as a rule, not in the stores themselves, but from the central offices. This method of collecting prices has led to the criticism that the quotations reported will be higher or lower than actual prices according to whether it is to the interest of the retailer to appear to be holding prices above or below the true market. During a depression period, when there is strong business pressure on retailers to avoid price cuts, a tendency for retailers to report prices higher than those they actually charge might be expected. On the other hand, during the present war, when the regulatory pressure is to hold prices below the levels they would reach in a free market, there may be a tendency for retailers to report prices lower than those they actually charge.

Answer: We have tested reported food price quotations through actual purchases at 159 independent stores and 37 chain stores in 17 cities.[1] Stores visited were selected from those reporting to the Bureau. Our buyers made these purchases as actual customers, not as Bureau or committee agents. Eleven hundred and twenty-seven purchase prices were compared with the same number of prices reported by the stores for the same dates.

862 purchase prices (76 per cent) were identical with reported prices;
90 purchase prices (8 per cent) were lower than reported prices;
175 purchase prices (16 per cent) were higher than reported prices.

We find a slight tendency for prices reported to the Bureau of Labor Statistics to understate prices actually charged customers. In its net effect this understatement involved a difference of not more than 1.8 per cent of the total cost of the foods priced.

To check the accuracy of food prices reported to the Bureau by central offices of food chains, agents of the Bureau, under the supervision of this committee, visited 200 individual chain stores, distributed among 6 cities.[2] Price reports to the number of 10,366 were obtained, for comparison with those reported by central offices for the same date.

8,023 prices in individual stores (78 per cent) were identical with those reported by central offices;
970 prices in individual stores (9 per cent) were lower than those reported by central offices;

[1] A test on May 18, 1943, covered Atlanta, Boston, Chicago, Cleveland, Dallas, Denver, New York, and San Francisco. A test on June 15, 1943, covered Atlanta, Detroit, Houston, Milwaukee, Newark, New York, Philadelphia, Salt Lake City, San Francisco, Seattle, Scranton, and Washington.

[2] The test, made on June 15, 1943, covered Atlanta, Detroit, Milwaukee, San Francisco, Scranton, and Washington.

1,373 prices in individual stores (13 per cent) were higher than those reported by central offices.

On balance, there is a slight tendency for prices reported by central offices to understate the prices charged in chain store outlets. In its net effect this understatement involved a difference of 0.6 per cent of the total cost of the foods priced.

We believe that these checks confirm the essential accuracy of the food prices reported to the Bureau. The observed discrepancies indicate a margin of reporting error of less than 2 per cent.

Our field tests were confined to food prices because these have been most frequently questioned in our hearings. However, members of the committee have accompanied the Bureau's agents and have observed the collection of the prices of other consumer goods. We believe these to be substantially accurate.

It should be noted that the obtaining of reported prices which at any one time are lower than the true prices does not necessarily reduce the accuracy of the index as a measure of changes over a period of time. If merchants since the beginning of the war have consistently underreported their prices, the trend of the index would not be affected. In any event, since the understatement in June 1943 was slight, it may be inferred that even if merchants tended to understate their prices somewhat more than before, the effects upon the index would be negligible.

2. *Are the retail stores included in the Bureau's sample representative of those patronized by wage earners and lower-salaried workers in metropolitan areas covered by the Bureau's compilations?*

The Bureau selects the stores from which it obtains prices on the basis of criteria which indicate where wage earners and lower-salaried workers in the city buy goods and services. The specific stores from which its agents obtain price quotations are necessarily changed over a long period but they are changed slowly. Some users of the index believe that migrations of labor during the war have changed the purchasing habits of the workers so drastically that the group of stores priced by the Bureau is no longer representative. They stress especially the belief that the changes in shopping habits have had the effect of transferring patronage from low-priced to high-priced stores. One example often given of this is the possible transfer of trade from city stores to suburban stores. Another illustration is the possible transfer of trade from chain to independent stores.

Answer: The only adequate way of answering this question would have been to ask a representative sample of workers where they made

their purchases. The Bureau, in selecting its sample of stores, considers many factors in order to assure itself that the stores selected are in neighborhoods where the income groups concerned purchase goods. We are satisfied that the Bureau's criteria are the best that can be devised without a new family survey. The weight given to chain and independent stores is based on comparative volume of business with respect to all income groups and not merely those included in the index. It has recently been revised to take account of wartime shifts in buying. If low income purchasers have shifted their marketing from one type of store to another, the weight given to each in the index may not truly reflect their comparative volume of business with respect to this group.

Since the elaborate survey necessary to answer this question by actual study of the purchasing habits of workers and other low income groups could not be made by this committee, we have undertaken two checks which throw indirect light on this problem.[3] Food prices were obtained in June 1943 from a number of independent retail stores in addition to those normally surveyed by the Bureau. One hundred and ninety-five of these were located within the limits of six cities[4] and 145 were located in the suburban areas of four cities in which there had been marked wartime expansion.[5] The latter sample was selected to ascertain whether prices in outlying areas in which there had been considerable population increases were higher than prices in the central cities. The criteria of selection employed were those used by the Bureau in obtaining its present sample of reporting stores. For each of 78 food products priced the average price in independent stores in the regular sample in a given city was compared with the average price in the added sample of independent stores in outlying districts of the city.

Four hundred and fifty-three[6] comparisons were made in testing the regular samples against samples drawn from within the limits of the same cities.

37 average prices from the check sample (8 per cent) were identical with those from the regular sample;

269 average prices from the check sample (59 per cent) were lower than those from the regular sample;

147 average prices from the check sample (33 per cent) were higher than those from the regular sample.

[3] The methods used in making these checks and their limitations are described in the Appendix.
[4] Atlanta, Detroit, Milwaukee, San Francisco, Scranton, and Washington.
[5] Detroit, Milwaukee, San Francisco, and Washington.
[6] Not all of the 78 foods were priced in each city.

The net effect of these discrepancies was to make the total cost of the food priced in the added sample of stores within city limits 1.7 per cent less than the cost of the same foods in the regularly reporting stores in the same cities. Statistical tests described in the Appendix show that this difference is not large enough to be significant.

Three hundred and five comparisons[6] were made in testing the regular sample against samples drawn from outlying areas of the same cities.

30 average prices in the outlying areas (10 per cent) were identical with those from the regular sample;
165 average prices in the outlying areas (54 per cent) were lower than those from the regular sample;
110 average prices in the outlying areas (36 per cent) were higher than those from the regular sample.

The net effect of these variations was to make the total cost of foods priced in the sample of stores in outlying areas 1.7 per cent less than the cost of the same foods in the regularly reporting stores in the cities proper.

We conclude that food price reports from the retail stores included in the regular Bureau sample are representative of prices prevailing in stores patronized by wage earners and lower-salaried workers in the cities covered by the tests made and in suburban sections of the metropolitan areas tested. In particular, we find in this evidence no support for the opinion that prices in independent stores in suburban districts are consistently higher than prices in independent stores in neighboring large cities.

These comparisons rest on samples of independent stores in representative metropolitan districts. We believe that the conclusions drawn are generally valid for such areas in the country at large. Exceptions may be found in specific boom areas. Smaller cities and towns are not included in the Bureau's cost of living index.

The tests here reported relate to price levels on a given date. On the committee's recommendation similar tests are being made for subsequent months in order that the regular sample and the added samples may be compared with reference to price changes over a period of time.

3. *To what extent is the Bureau's index of living costs affected by the omission of black market prices?*

Wartime ration and price controls have led to a widespread belief that much retail trade is now being done at prices far above officially established ceilings through both regular and irregular channels of

distribution. If this were true, and if above-ceiling prices were not adequately represented in the Bureau's compilations, the cost of living index would be biased downward.

Answer: We distinguish between black markets proper, in which rationed goods are sold without exchange of ration coupons, and retail stores in which some goods are sold at above-ceiling prices, with surrender of ration coupons by customers. We have made no systematic investigation of markets of the first type. The questioning of informed witnesses indicates that the families to which this index relates do not purchase important quantities of goods in such markets. The Bureau does not attempt to obtain price quotations in these markets. It is the opinion of the committee that it should not do so. *Transactions in rationed goods effected without exchange of ration coupons should not be represented in an official index of living costs.*

The Bureau does obtain above-ceiling prices charged in ordinary retail outlets, with customary exchange of ration coupons, and these prices are included in the index. Among the prices reported for April and May 1943 for pork products, 1,981 out of a total of 8,707 (23 per cent) were above ceilings. It is not likely, however, that all such cases are reported to the Bureau. The net difference between reported prices and the purchase prices recorded in our field tests is an indication of the possible magnitude of the effect of the failure to report all above-ceiling prices. We conclude that there is probably an error in the index because of the under-reporting of above-ceiling prices by ordinary retail outlets, but that for food products this error does not exceed 2 per cent.

4. *Does the index of living costs measure hidden price increases due to quality deterioration?*

Although the formal quotation for an item may remain unchanged, its true price may be raised by reducing the quality offered. Thus, a shirt quoted at $1.95 throughout the war may have increased substantially in price if the quality has deteriorated. Critics of the index argue that this sort of hidden increase in prices has been very large and is not reflected in the index.

Answer: The Bureau of Labor Statistics seeks to hold quality factors constant by pricing goods with specified characteristics. For many types of consumer goods it is able to do so today. For other goods and services quality deterioration is an inevitable accompaniment of the war effort. The lessened comfort of traveling, reduced delivery and laundry services, the use of cuts of meat of lower grade, are examples of quality deterioration that we accept as necessary under war conditions.

With limited exceptions these quality reductions are unavoidable. This does not mean that all consumers are today buying goods of lower quality. Many workers whose incomes have risen during the war are buying clothing and food of higher quality than they could afford in the past. These come at higher prices, and mean to the buyer a higher level of family expenditures. To the degree that higher quality goes with the higher prices this is a change in the level of consumption, not an increase in the cost of living.

With reference to the cost of living index, our concern is with the price equivalent of quality change. *We believe that consumers' goods and services, in the aggregate, have since 1939 suffered some loss of quality that is not reflected in reported prices. No dollar value can be put on this loss. In large part it is an intangible and unmeasurable element of the war. Consumers cannot be compensated for it. The cost of living index takes incomplete account of it.*

5. *Are the rents reported to the Bureau those actually paid by tenants?*

Some users of the index have been under the impression that rentals are still obtained from rental agents, who are under pressure from the rent control authorities, and that the rent reports are, therefore, biased downward.

Answer: We have made no field check on this point, but we have examined the Bureau's procedure. We find that all rental reports are now obtained directly from tenants by agents who visit their homes. We believe that the rents thus reported are free from bias and may be accepted as accurate.

6. *Are the housing facilities included in the sample representative of those occupied by wage earners and lower-salaried workers in large cities?*

Answer: The Bureau's housing sample prior to September 1942 was made up of houses and apartments handled for the owners by rental management firms. This sample was losing its representative character under conditions of housing scarcity and rent control. Between September 1942 and June 1943 a complete new sample was drawn in each city covered. The total number of family dwelling units included is 51,500.

In our opinion the new samples are satisfactory representations of family dwellings in the cities represented in the general index. We do not believe that these 34 cities adequately represent the diversity of urban housing conditions in the country as a whole. We recommend that advantage be taken of rental surveys now in process or being planned by the Bureau and the Office of Price Administration to increase the coverage of the index.

We note one other limitation on the coverage of the Bureau's sample. This includes family dwelling units only. Under wartime conditions single rooms and portions of former family dwelling units have become more important as living quarters for workers. Evidence presented to the committee indicates that rental rates for individual rooms and for parts of family dwelling units have risen more rapidly in many congested war centers than have rentals for whole family dwelling units. We note, however, that the amount spent on room rentals in the spring of 1942 by urban families of two or more persons amounted to only about 1.9 per cent of all expenditures on housing by such families (*Study of Spending and Saving in Wartime*, a pending publication of the Bureau of Labor Statistics). Today such expenditures may be in the neighborhood of 2 per cent of the total amount spent on housing by urban families of moderate income. The inclusion of these expenditures in the Bureau's rent index, even at levels well above those of 1942, would affect the total cost of living index only slightly.

7. *Does the Bureau's rent index accurately measure recent changes in the cost of housing to wage earners and lower-salaried workers living in large cities?*

Answer: *We believe that for the areas covered by the Bureau's sample the index of rents provides an acceptable measure of changes in the cost of housing for urban workers who live in the same communities and in residences of the same general types as those occupied before the defense and war effort.* We point out, however:

(a) There has been deterioration in the quality of housing in certain regions. For example, houses on the average are older, and a larger proportion of those included in the index are in need of repairs and renovations if pre-war standards are to be maintained. This deterioration is in some degree unavoidable and in some part unmeasurable. It constitutes a loss that is not taken account of in the index of living costs. However, the committee would point out that certain directly measurable changes, such as the discontinuance of "free rent" for certain periods of the year or the shift of payments for water or heat from landlord to tenant are recorded by the Bureau as rent increases.

(b) Workers who have moved from low-rent to high-rent areas and workers who have moved from family dwelling units to rooms in lodging houses or homes have experienced substantial advances in housing costs. These advances are not measured by the rent index of the Bureau of Labor Statistics. These changes are illustrations of the changes in manner of living referred to above.

Although they may have an important effect upon family expenditures they cannot be measured by an index designed to record changes in unit prices over a period of time.

8. *Are the goods and services priced now typical of those purchased by wage earners and lower-salaried workers in large cities?*

An index of the cost of living, if it is to be meaningful, must measure changes occurring in the prices of what is actually consumed. The committee has given attention, therefore, to the methods by which the Bureau has adjusted the elements of the index to changes in consumption.

Answer: The basis for the selection of commodities and services included in the index is a study of consumer expenditures relating to the years 1934–36. The standards represented in that selection related to the consumption of urban families supported by wages or clerical salaries with incomes averaging about $1,500. These standards were somewhat higher than the level of expenditures of this group in the thirties because the sample did not include families receiving relief of any kind or families with incomes under $500. With the rising incomes of 1939 and succeeding years, wage earners' expenditures probably came closer to the standards on which the cost of living index is based. As of 1940 the commodities and services included in the index were probably more representative of actual consumption by urban workers than they had been five years before. Since 1941 rationing and the disappearance of commodities have altered the kinds and quantities of goods and services consumers can buy. Corresponding changes have been made in the composition of the index of living costs.[7] Durable metal goods have been virtually withdrawn. The current food index was adjusted in March 1943 on the basis of the Department of Agriculture's estimates of expected consumption of different kinds of food in 1943. Other elements of the index have been altered to accord with rationing orders. There is no completely satisfactory solution of the problem faced by makers of a cost of living index when the character of consumption is changing. We believe that the adjustments made by the Bureau represent a reasonable compromise between the desire to reflect current consumption and the desire to maintain an index that measures with accuracy average changes in the unit prices of consumer goods and services.

We would add that changes in the kinds and quantities of goods consumed by average families in the United States have not as yet been

[7] See Appendix. See also "Bureau of Labor Statistics Cost-of-Living Index in Wartime," by Faith M. Williams, in the July 1943 *Monthly Labor Review*.

very great. Mass consumption is slow to change. Purchases of new durable goods are, of course, smaller, but such goods constitute in normal times only some 10 per cent of consumer outlay for families with moderate incomes. For wage earners and salaried workers in the country at large, the distribution of expenditures for food, clothing, and rent has not been substantially modified.[8] The index of living costs, it must be remembered, relates to changes in the average situation of city wage earners and clerical workers, not to the experience of particular families.

9. *Does the index of living costs measure changes in average family expenditures on consumer goods and services?*

This question reflects the popular interpretation of the phrase "cost of living" as representing the total amount families spend for goods and services.

Answer: No. The index is designed to measure only those changes in family expenditures resulting from changes in unit prices. It is not designed to measure alterations in family expenditures resulting from changes in manner of living, whether the changes are due to choice or necessity.[9] Such alterations can be measured only by other statistical devices, such as direct inquiry into actual family incomes and expenditures or the index of consumer expenditures now being published by the Department of Commerce. The distinction between changes in family expenditures due to price movements and those due to shifts in the way of living is of special concern today when the pattern of living is being altered for a great many consumers. Rising incomes are giving many families opportunities to live on higher levels than they have known before.

10. *Does the Bureau's index provide an acceptable approximation to recent changes in the cost or living for urban workers?*

Answer: Yes.

The index shows the following changes in the cost of living in the United States:

from March 1943 to August 1943	+ 0.3 per cent
from September 1942 to August 1943	+ 4.6 per cent
from January 1941 to August 1943	+22.2 per cent
from August 1939 to August 1943	+24.9 per cent

[8] See the comparative distributions of consumer expenditures from 1939 to 1942, *Survey of Current Business*, March 1943.

[9] Certain forced changes are taken into account by recently introduced methods of treating the difference in price between a higher-priced article and one no longer available as a price increase.

The various tests we have made indicate that these measurements define with satisfactory accuracy changes in the prices of the goods and services purchased by urban workers.

With this statement we repeat two necessary explanations and two necessary qualifications.

(a) The index relates to living costs for wage earners and lower-salaried workers in large cities.

(b) The index is primarily a measure of changes in the average unit prices of consumer goods and services. It does not measure changes in family expenditures resulting from changes in income or in the place or manner of living.[10] The general effect of the shifts in incomes and in ways of living that have occurred since 1939 has been to advance total family expenditures at a rate greater than that shown by the Bureau's index of living costs.

(c) The index does not measure the full effects of quality deterioration in certain consumer goods and services and in housing.

(d) The kinds of goods and services used by the average family have changed somewhat under the impact of war and will continue to change. The Bureau has made changes in the list of goods that it prices and has altered the relative importance of component items to take account of the disappearance of goods and changes in consumption resulting from rationing. These shifts are reflected in the index. Their effect on the actual course of the index has not been great. Checks made by us show that price changes have dominated the movements of the index in recent years.

We have said that the index provides an acceptable approximation to recent changes in living costs. *We believe that as a measure of price changes affecting urban workers in large cities it is a good approximation.*

11. *Is the index an adequate instrument for use in matters of public policy?*

Those charged with the formulation of public policy and its implementation must frequently make use of an index of living costs. The President, Congressional committees, and public agencies such as the War Labor Board, the Social Security Board, the Office of Price Administration, the Treasury, Bureau of the Budget, State Department,

[10] Many such changes have come with recent migrations of labor and occupational shifts. Because occupational shifts have, in general been from lower to higher pay industries and from lower to higher paid jobs within industries, personal and family incomes have advanced more rapidly than average wage rates and much more rapidly than living costs. The Department of Commerce estimates that the average annual compensation of employees (wage earners and salaried workers combined) in private nonagricultural industries increased 37 per cent between 1939 and 1942 (from $1,268 to $1,733). Living costs increased 17 per cent in the same period.

and others must consider the economic experience of citizens as reflected in the index in formulating and in evaluating the effect of their several policies.

Answer: We have indicated our conviction that the index is a satisfactory instrument for measuring what it attempts to measure—average movements in the retail prices of goods and services purchased by city workers. If public policy is in need of a guide on this point, the index is a satisfactory one.

In general it can be said, therefore, that the greater the dependence of public policy upon a measurement of what is happening nationally to prices of consumers' goods, the more useful the index is. On the other hand, the greater the dependence of public policy upon a measurement of what is happening to prices in particular areas, for particular population groups, and for particular commodities not covered by the Bureau, the less useful it becomes.

The value of the index for certain uses is greatly enhanced if it is used as one among several measures rather than alone. For some problems it should be used as a first approximation to the truth, to be corrected by knowledge of the particular situation. A thermometer reading is useful to the physician if used in conjunction with other indicators of the health of the patient and as a guide to further diagnosis.

We cite three examples of public use of the index to illustrate our point:

(a) *Use of the index to measure the degree of inflation.*

If we define inflation as a situation in which the aggregate value of all goods and services exchanged in an economy increases more rapidly than the physical volume of these goods and services, a cost of living index is an obviously relevant measuring tool. The Bureau of Labor Statistics index, however, does not cover all consuming groups in our economy. It relates only to the retail prices of consumers' goods purchased by families of moderate income in large cities. Prices in primary markets and in various wholesale markets are also important indicators of inflation. For this reason we do not believe that the Bureau's cost of living index should be used by itself as a measure of the extent of inflation. It has great value as one among a group of measurements available to administrators of an anti-inflation program.

(b) *Use of the index in the control of retail prices.*

The index is a useful instrument in retail price control. Its use would be greater if coverage were broadened to include prices of more commodities. However, it should be remembered that the

commodities selected for measurement are chosen not only because they are important in the customary purchases of consumers, but also because their price movements are like those of related commodities. If the present national and city averages were supplemented by regional measures and by more detailed index numbers for commodity groups, their usefulness would be greatly increased. Effective price control cannot be based solely upon averages comprehending great diversity.

(c) *Use of the index as an instrument in making wage and salary adjustments.*

On the general question of policy involved in deciding whether wage rates and salaries should in times of peace be adjusted in accordance with movements of an index of living costs the committee does not speak. However, we have been asked to appraise the Bureau's index with reference to the uses to which it is now put. If the index is to be appropriately used in this connection, several facts must be kept in mind.

The general index is a national average, and relates to large cities only. There is considerable variation in the level of living costs in different parts of the country, and in the degree of change in living costs in different regions. There are industrial variations in living costs. Costs in coal towns and textile towns are affected by special factors and have distinctive movements. Living cost changes vary also with income levels. Recent advances have been somewhat greater for workers at lower income levels because foods, which have risen sharply in price, are of greater importance in the budgets of low-income families.[11] Such variations are characteristic of economic changes in a system as diverse as that of the United States.

These facts have relevancy for several possible uses to which the index may be put in connection with wage and salary adjustments. In the first place, *in the application of general wage policies of national scope it is proper and necessary to utilize a measure that averages these varying movements, as a national index does. If wages and salaries of workers in particular regions, in particular industries and at particular income levels are to be adjusted to living cost changes affecting them specifically, indexes of living costs adapted to special circumstances will be required.* The construction of adequate

[11] Furthermore, the actual family expenditures of low income groups have probably risen more than those of higher income groups because consumers at low income levels have not been in position to economize by purchasing goods of lower grades than those to which they have been accustomed in the past.

regional and other special purpose index numbers of living costs would involve broader sampling and heavier expenditures by the Bureau of Labor Statistics.

The use of the index in such specific wage adjustments is not, of course, the one which is currently most significant. Wage rates cannot be contractually geared to the movements in the cost of living index under the Federal Government's present stabilization policy if to do so would result in wage increases inconsistent with that policy. In the Government's stabilization program the cost of living index has two uses: first, to explain the 15 per cent increase in wage rates permitted by the "Little Steel" formula, and second, to give an indication of the pressure placed upon present wage rates by workers' experience in meeting the rising cost of living. We have found no evidence that would invalidate the index for the first purpose. For the second purpose, however, that of estimating the pressure on present wage rates and the present wage adjustment formula by workers' experience with living costs, a national average of living costs is not satisfactory. The reason for this does not arise from any inaccuracy, but from the fact that it is an average. The experience from which dissatisfaction comes is not that of the statistical average man. It is the experience of the individual worker or group of workers involved.[12]

The fact that the index is one of prices and not of consumers' actual expenditures should provide further warning. The difference between the movements of prices and changes in actual expenditures is significant in times of great mobility, changes in the pattern of living, commodity and housing shortages, quality deterioration, and increased taxes and bond purchases. Since a price index cannot reflect completely these facts of consumers' experience, it cannot fully measure what workers mean by changes in their cost of living. The dissatisfaction or satisfaction of workers arises from their own and not the statistician's conception of the "cost of of living" in relation to their own and not the average income.

One further point needs emphasis. A decline in the plane of living cannot be prevented in an economy that absorbs a large part of the country's products for military purposes. When the total available supply of consumers' goods declines, the real income and the plane of living of the average citizen must decline. If the wages and salaries of

[12] It should be pointed out also that the worker's dissatisfaction with living costs is modified somewhat by his earnings and that changes in total earnings from whatever causes are important in this connection as well as changes arising solely from the alteration of wage rates.

any group or the prices received by any group are geared to a cost of living index, making it possible for them to purchase the same volume of goods as before, the consequences are clear. The remainder of the population whose income is not geared to the index must suffer a greater decline in their plane of living than would be expected in view of the reduction in the available supply of consumers' goods. It is not intelligent conservation of the nation's human resources, of course, to permit a reduction in the plane of living of those living at or near subsistence levels. But for the population at large war means reduced consumption.

The use of a cost of living formula to adjust the income of one group of citizens will not prevent reduction of consumption for citizens generally. It can result only in shifting a larger share of the burden of that reduction onto the shoulders of those whose income is not geared to the formula. The preferable alternative is one that combines rigorous and extensive taxation, government borrowing from individuals, rationing and price control as means of restricting consumption, keeping inflationary forces in check and insuring an equitable sharing of the burdens of war.

RECOMMENDATIONS TO THE BUREAU OF LABOR STATISTICS

In the course of its hearings and work the committee has reviewed the many uses the Bureau of Labor Statistics must take into account in making its cost of living indexes more effective during the war and in the coming period of reconstruction. The following recommendations are based upon this review. They are made with the understanding that proper consideration will be given to the costs of the studies proposed, as well as to the needs of administrators and legislators for the information these studies will yield. The Bureau and the appropriate Congressional committees will weigh the expected benefits against these costs.

With this proviso, the committee recommends:

1. That the Bureau of Labor Statistics provide *separate regional* indexes of changes in city living costs. The economic differences between the several large geographic areas of the United States make it essential that separate indexes of the cost of living for various regions be prepared.
2. That the Bureau expand its indexes of the cost of living in small cities so that they will be as representative of these cities as the large city indexes are for large cities.
3. That the Bureau cooperate with other interested governmental agencies to collect the information necessary and to prepare an

index of the cost of living for *non-farm* communities in the United States.

4. That the Bureau take steps immediately to prepare and publish cost of living indexes for:
   a. Communities of different sizes.
   b. Certain specialized industrial areas, such as those in which coal mining, textiles, etc., are concentrated.
5. That the Bureau immediately expand its work on the development of measures of geographic differences in cost of living; and that analyses of these differences be continuously carried on.

To carry out the foregoing recommendations, it will be necessary for the Bureau immediately to expand its samples of large and small cities, and employ existing information and collect additional data to develop weights which will reflect the geographic, industrial, and economic factors involved in the proposed indexes.

6. That frequent *small-sample studies of family expenditures and incomes* be conducted, and that once in 5 years a comprehensive study be made to provide data on local differences in income and consumption habits among occupational groups in the United States. Furthermore, that adequate analyses and integration of these studies and existing data be planned and regularly provided for. Since these kinds of studies provide the weights which reflect the changes in consumption habits and are important in keeping the cost of living indexes in line with current economic development, it is essential that they be made periodically.
7. That the Bureau undertake analyses of the shifting importance of the various items included in family budgets and the degree to which these items are correlated with other items in price movement. To keep sufficiently abreast of these kinds of changes, the committee feels that a comprehensive study of the inter-relationships of price changes and of the correlation between price changes and other factors (size of community, quality and season) should be made.
8. That the Bureau *publish average prices* for the principal commodities and services in each of the major groups of consumption and that as rapidly as the validity of the samples and averages of sub-groups of these goods and services can be assured, that indexes and average prices for these groups also be published. For general index purposes, some of the Bureau of Labor Statistics samples (of cities, goods and services) might be reduced; the pressure for increasing detail on the part of those

using these indexes, however, requires larger samples for most phases of the work. At the present time—except for foods, fuels, and certain other commodities—the Bureau of Labor Statistics is not warranted in publishing basic data on average prices by cities because the samples have in general been considered as inadequate to provide more than stable relatives for large aggregates of commodities and services.

In periods of rapid changes in consumption habits, the specifications of goods and services purchased by consumers, as well as the lists of stores from which consumers buy, must be reviewed at frequent intervals if the cost of living index is to be maintained as a dependable instrument.

9. That the Bureau pay continuous attention through special studies to changes in the *specific consumer goods and services* which it prices, continuing the survey of wartime prices initiated in the spring of 1943.
10. That the Bureau conduct frequent field surveys to determine the necessity of changing the number of outlets from which prices are obtained, or of shifting from outlets in one area to those in another, in order to maintain adequate samples for the indexes, as well as for the average prices.
11. That the Bureau prepare for publication an historical summary of the development of the concept of the cost of living index and of the purposes for which that index is used. The Bureau of Labor Statistics index of the cost of living has been developed with gradual improvements in methodology since the introduction of the index of food costs in 1903 by the Commissioner of Labor Statistics. The report herein recommended should, in addition, describe the expansion of uses to which the index has been put, and provide an explanation of the ideal form of index which would serve these several purposes.

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HOUSING SCALES FOR RURAL PENNSYLVANIA

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Evaluations of housing, whether of a slum area or of an individual dwelling, are always based upon certain criteria. Too often the criteria are ill chosen and inconsistently weighted. In this article it is assumed that the comparative usefulness of various criteria can be empirically determined and weighted accordingly. What follows is a description of the reliability and the validity of three scales of varying length for measuring rural housing in Pennsylvania. The scales were constructed from data collected in 1941 through interviews with 517 rural householders[1] concerning 57 housing items.

Housing, for purposes of this study, was defined broadly to include the house structure together with the equipment and the site. More precisely, housing was defined in terms of the 57 specific component items, although at this stage the relative importance of each had not been determined. One object of preparing a scale was, of course, to permit measurement in terms by which housing could be defined more explicitly, that is, operationally.

In constructing the scales two preliminary subjective evaluations were made by the author: first, the selection of the 57 specific items; and second, the designation of categories for each of the 57 items and their arrangement on a continuum from poorest to best housing (i.e., poorest or best as judged subjectively in terms of desirability in Pennsylvania culture). Four distinct methods of assigning weights to the categories of each item were then tried. After testing the reliability and validity of the weights finally adopted, the possibility of reducing the number of items without sacrificing too much reliability and validity was explored and three abbreviated scales comprised of 10, 20, and 30 items were constructed.

The first method involved the assigning of *a priori* weights to each category of each of the 57 component items by the author. A second method used as weights, values which took account of the frequency of occurrence of each category of each component item; that is, the percentages of families possessing each category of each component were converted into standard-deviation units by reference to an area table. A third method was based upon calculated values which indicated the

[1] For a statement of the sampling procedure see *Housing and Attitudes Toward Housing in Rural Pennsylvania*, Pennsylvania Agricultural Experiment Station Bulletin 436, and *Measurement of Housing and Attitudes Toward Housing in Rural Pennsylvania*, Pennsylvania Agricultural Experiment Station Technical Paper No. 1149 (mimeographed).

degree of probability that each item was diagnostic of total housing, that is, critical ratios of differences between high-scoring and low-scoring classes of families. A fourth method determined weights for each category of each component item through a series of successive approximations in which *a priori* weights were successively revised by assigning as an item weight the average score of all other families possessing that item. Each of these methods is described more fully below. Let *A*, *B*, *C* and *D* designate the four methods in the order described above.

Method A of assigning weights to each category of each housing item was admittedly subjective. It rested upon preconceptions of the author as to the relative importance in rural Pennsylvania culture of each characteristic (each type or category) of each of the 57 component items and upon the assumption that each component item should be given approximately equal weight in the total score. More explicitly, the author arbitrarily decided that the presence of an electric sweeper (one category of one of the 57 component items) warranted a higher score than the presence of a hand sweeper (mechanical but not power-driven), and that the latter warranted a higher score than the absence of

TABLE I

PER CENT OF LOWEST, MIDDLE AND HIGHEST THIRDS OF THE FAMILIES CLASSIFIED ACCORDING TO HOUSING SCORE *A* POSSESSING SPECIFIED HOUSING ITEMS*

Housing items and rank according to column 6	Per cent of families possessing specified items				Average "t" value of percentage differences between thirds
	All families	Lowest third "poorest"	Middle third "medium"	Highest third "best"	
1	2	3	4	5	6
1 Inside toilet with sewage system	46	4	42	94	11
2 Fully equipped bathroom	44	2	37	92	11
3 Electric sweeper	50	8	53	88	9
4 Central heating system	44	6	44	82	8
5 Running water in house	61	25	64	95	8
6 Monthly rental value of $20 or more	33	3	27	69	7
7 Sale value of house $1,500 or more	67	32	73	96	7
8 At least ½ closet per person	46	15	44	78	7
9 Kitchen sink with drain	78	48	88	99	6
10 Electric or gas refrigerator	41	11	42	70	6
11 Electric iron	82	55	93	99	6
12 Separate living room, dining room, kitchen and bedroom	62	33	65	87	6
13 Exterior paint unchecked	40	13	41	65	5
14 Electric lights in house	84	62	93	99	5
15 Telephone	27	5	18	48	5

* Items in this table are classified dichotomously and only the "desirable" category is shown. The table mentioned in footnote 5 shows a full list of categories of each item.

TABLE I—*Continued*

Housing items and rank according to column 6	Per cent of families possessing specified items				Average "f" value of percentage differences between thirds
	All families	Lowest third "poorest"	Middle third "medium"	Highest third "best"	
1	2	3	4	5	6
16 Walls of unbroken plaster	64	37	71	85	5
17 Walls—papered, painted or decorative plaster	73	47	79	92	5
18 Full basement with cement floor	21	4	16	43	5
19 Gas or electric cook stove	35	13	34	59	5
20 At least 1 room per person	88	70	95	100	5
21 Lawn and plantings in yard	63	37	67	83	5
22 Water system enclosed	70	48	72	91	5
23 Unbroken screens on windows	79	66	97	99	5
24 Not infested with vermin	64	42	65	84	4
25 House structurally sound	89	71	97	99	4
26 Roof of asphalt, asbestos, tile or slate	54	32	57	73	4
27 At least 200 sq. ft. per person	69	49	71	87	4
28 House of lapped planed siding, shingles, brick, stone, stucco, concrete or cinder blocks	90	73	98	99	4
29 Services within 1 mile	43	24	40	62	4
30 Steps of solid material	87	66	97	96	4
31 Blinds, drapes and/or curtains	91	75	97	99	4
32 Doors unbroken	90	75	97	99	4
33 Floors of grooved wood	87	74	89	98	4
34 Radio	91	77	98	99	4
35 At least ½ bedroom per person	88	75	91	98	3
36 At least 100 sq. ft. bedroom space per person	59	43	57	76	3
37 Power driven washing machine	80	61	85	93	3
38 House owned by family	64	49	61	81	3
39 Ceiling 8 to 10 feet high	83	67	89	93	3
40 No leaks in roof	85	71	90	94	3
41 Neighbors within ¼ mile	84	73	83	94	3
42 Foundation of solid walls	96	87	99	100	3
43 Woodwork painted or varnished	97	92	98	100	2
44 Unbroken glass in windows	95	86	99	99	2
45 At least 1 sleeping unit per person	93	86	95	98	2
46 House insulated	10	3	10	16	2
47 At least 20 sq. ft. of windows in living room	9	2	9	14	2
48 Kitchen cabinet with enclosed shelves	95	86	99	98	2
49 Power driven sewing machine	6	2	5	11	2
50 Floors covered	99	96	100	100	1
51 Garbage hauled or destroyed	98	94	100	99	1
52 House more than 100 ft. from barn, pens, railroad, factory, etc.	91	87	92	94	1
53 Hard-surfaced road adjoins lot	75	70	74	79	1
54 No obvious fire or traffic hazards	74	72	72	78	1
55 House under 10 years old	7	6	7	9	1
56 Single family structure	90	90	90	90	0
57 Working place within 2 miles	62	67	55	64	0

mechanical sweeping facilities; moreover, the author assigned the weights of 6, 3 and zero to these three categories (types) of the item, sweeping facilities. The assumption that sweeping facilities should be given approximately the same weight in the total as each of the other 56 component items was protected by limiting the range of scores from zero to 6, assigning the highest at 5 for dichotomous items and 6 for items of $3 \cdot \cdot \cdot n$ categories and the lowest at 1 or zero. *A priori* weights were assigned to the various categories of each of 57 component items for which information was obtained. Table I indicates the 57 items. The total housing score for a family was the arithmetic average of the weights assigned to each item.

$$A = \frac{\sum a_k}{n},$$

where A represents the composite score, a_k represents the *a priori* weight assigned to item k, and n represents the number of items for which information was available (57 in most cases). In assigning these weights other studies together with the evaluations of other persons were drawn upon in the hope that the method, which involves much less work than other methods, would prove reliable when subjected to empirical verification by methods *B*, *C* and *D*. The *A* scores of the families studied ranged from 1.8 to 5.5.

Method B was designed to overcome one of the shortcomings of Method *A*; namely, that it does not provide differential weights for those desirable categories which are common in contrast to those which are rare. For example, 97 per cent of all dwelling units had painted or varnished woodwork (a desirable category of one of the 57 components) as compared with 6 per cent of the total that had electric sewing machines (a desirable category of another component). To assign weights empirically that quantitatively represented frequency of occurrence of categories (in terms of desirability), the percentages of dwellings in each category were converted into standard-deviation units of the normal probability integral. The procedure involved first the arraying of the categories of each component in order from least desirable to most desirable. For each of the 57 components the array of categories was exhaustive, that is, it covered 100 per cent of the categories. In the accumulated array, therefore, the least desirable category fell between zero and the percentage of dwellings in the category. The most desirable category fell between 100 per cent and 100 minus the percentage of dwellings in the category. Mid-points of these

percentage ranges were then converted into standard-deviation units. The whole procedure is illustrated in an example. No mechanical sweeping facilities were present in 42 per cent of the houses, hand (non-powered) sweepers in 8 per cent, and electric sweepers in 50 per cent of the dwellings. The accumulated percentages were 42, 50 and 100; the mid-points (which were used to represent the category) were .21, .46 and .75. These mid-point values minus .50 (since area-tables are in terms of .50 of the area under the normal curve) were −.29, −.04 and +.25; the corresponding standard deviation units were −.8, −.1 and +.7; and the final weights (the sigma scores plus a constant 3.0 to eliminate negative signs) were 2.2, 2.9 and 3.7. The composite index for a dwelling was the arithmetic average of its scores for each component item.[2]

$$B = \frac{\sum b_k}{n},$$

where B represents the composite index, b_k represents the score on component k expressed in sigma units, and n represents the number of components for which information was available (57 in most cases).

Method C was designed to overcome a second criticism of scale *A*; namely, that it does not give greatest weight to those components that are most diagnostic of (most highly correlated with) the total score. The procedure involved the use of the total score obtained by Method *A* as a preliminary criterion upon which all families could be classified as having best, medium and poorest housing. It was then possible to determine which categories of each component were most and which were least common among the three classes of houses. In the category "inside toilets," for example, were 4 per cent of the poorest, 42 per cent of the medium and 94 per cent of the best classes of houses. To determine the significance of the differences among the successive classes, critical ratios were calculated for each of the 57 components between (a) poorest and medium and (b) medium and best. The final weight for each item was, then, the arithmetic average of the two critical ratios. The total score for each dwelling was the arithmetic average of the weights for the 57 items.[3] Table I shows the average "*t*" values of each item.

[2] For other examples of the application of this method see A. M. Leahy, *The Measurement of Home Environment*, Minneapolis: University of Minnesota Press, 1936; W. H. Sewell, *The Construction and Standardization of a Scale for the Measurement of the Socio-Economic Status of Oklahoma Farm Families*, Stillwater: Oklahoma Agricultural Experiment Station Technical Bulletin 9. 1940; H. R. Cottam, *Methods of Measuring Level of Living, Social Participation and Adjustment of Ohio Farm People*, Columbus, Department of Rural Economics and Rural Sociology, Mimeographed Bulletin 139, 1941.

[3] For other examples of the use of this method see Leahy, *op. cit.*, Sewell, *op. cit.*, and Cottam, *op. cit.*

$$C = \frac{\sum c_k}{n},$$

when C represents the composite index for a family, c_k represents the weight of the kth item, and n represents the number of components for which information was available. A serious disadvantage of this method is that each of the 57 components was forced into a dichotomous classification, whereas methods A, B and D permitted several categories and therefore greater refinement in weighting.

Method D was used to meet the chief criticism of Method A; namely, that the use of *a priori* weights is based upon subjective evaluations. A series of successive revisions of the *a priori* weights of each component were made in terms of averages of total scores of all 57 components for all dwellings. The method rests upon the belief that the usefulness of any single component item for predicting total housing can be repeatedly improved by using each successive revision of the total scores in revising the weights of the component items. Successive approximations were repeated until there was no marked change in the weights of the 57 component items from one revision to the next. More explicitly, the weights of Method A were temporarily accepted as first approximations which then required empirical revision to eliminate subjective evaluations. These weights of each category of each component were then revised by taking as the second-approximation weights the mean total housing score (M_N) of all dwellings reported in the Nth category of the component (i.e. all dwellings having the Nth category). These M_N scores were, however, first converted into comparable units with the mean score of all families M_D as a stable point of reference and with a $.3\sigma_D$ as a divisor which would give a reasonable range to the weights. Let O_N represent the weight to be assigned to the Nth component-category; let σ_D represent the standard deviation of the total housing scores; and let 5 be a constant. Then

$$O_N = \frac{M_N - M_D}{.3\sigma_D} + 5.$$

Now solving for M_N to simplify conversion to O_N by preparing a table of corresponding M_N and O_N values,

$$M_N = .3\sigma_D O_N - 1.5\sigma_D + M_D.$$

Finally, the total score (D) was

$$D = \frac{\sum O_N}{n},$$

where n represents the number of components for which information was available (57 in most cases). Consider the case of one component item, for example. The mean A score of all dwellings having an electric sweeper was 5.34, the mean score of those having hand (non-powered) sweepers was 5.08 and the mean of those having no mechanical sweeping facilities was 4.15. These were the M_N weights used in the second approximation, and upon the basis of them a new composite score D_2 was calculated ($D_1 = A$). Upon the basis of D_2 new weights were again assigned and D_3 was calculated. Similarly D_4 was calculated.[4] At the fourth approximation D_4, the weights had stabilized to a point where there was little change from one approximation to the next. And

$$r_{D_1D_2} = .983; \qquad r_{D_2D_3} = .995; \qquad r_{D_3D_4} = .996.$$

The principal advantage of this method is that items which bear no empirical relationship to housing are automatically reduced so that they exert no effect on the total score. Moreover, reliability and internal consistency are maximized. The main shortcoming is that categories which are infrequently present (i.e., low frequency) are subject to great chance fluctuations which are not corrected by the successive approximations.

Methods A, B, C, and D were found to result in strikingly similar housing scores for the sample families although the weights for various categories of the 57 items differed in some respects, particularly in those items which were not highly diagnostic of the total score. A table showing the weights assigned by methods A, B, C, D_1, D_2, D_3, and D_4 to each category of each of the 57 items has been prepared.[5] The intercorrelations (Pearsonian r) of the housing scores found by the four methods are as follows:

$$r_{AB} = .96 \qquad r_{BC} = .94$$
$$r_{AC} = .95 \qquad r_{BD_4} = .95$$
$$r_{AD_4} = .96 \qquad r_{CD_4} = .96$$

For purposes of constructing abbreviated scales of rural housing that might be standardized by subsequent testing, the weights adopted were those assigned by Method A with slight revisions to decrease the number of categories in certain items. The weights used in the abbreviated scales are shown in Table II. The criterion for selection of items to be

[4] For a more detailed statement of this method see Charles I. Mosier, *Measurement in the Field of Rural Housing* (typewritten) University of Florida. June 1941, pp. 32–37; 153–156b.

[5] Copies of this table in mimeographed form can be secured from the author.

TABLE II

WEIGHTS FOR ABBREVIATED HOUSING SCALES OF VARYING LENGTHS

(Combine first 10, first 20, or all 30)

Score = $\Sigma s/N$ where s is score of each item and N is number of items included

Rank of item	Housing item and weight
1	Toilet facilities: none (0); outside (2); inside—outside surface drain (3); inside—leechy cesspool (4); inside—septic tank(5); inside—public sewage (6).
2	Bathroom equipment; none (0); room, no fixtures (2); tub or shower only (4); lavatory only (4); shower or tub and lavatory (6).
3	Kind of sweeper: none or broom (0); hand carpet sweeper (3); electric sweeper (6).
4	Kind of heating system: fireplace, wood-coal (0); range (1); heater, wood-coal (2); gas heater (3); pipeless furnace (4); piped air (5); steam or water (6).
5	Water conveyance system: carry (0); hand pump, porch (1); hand pump, inside (2); running, cold (4); running, hot (6).
6	Monthly rental value: $0–4 (0); $5–9 (1); $10–14 (2); $15–29 (3); $30–39 (4); $40–49 (5); $50 and over (6).
7	Sale value of house: $0–249 (0); $250–499 (1); $500–1,499 (2); $1,500–1,999 (3); $2,000–3,999 (4); $4,000–4,999 (5); $5,000 and over (6).
8	Closet facilities per person: 0–.4 (0); .5–.9 (1); 1.0–1.4 (2); 1.5–1.9 (3); 2.0–2.4 (4); 2.5–2.9 (5); 3.0 and over (6).
9	Kind of kitchen sink: none (0); undrained (1); drained to surface (2); drained to sump (4); sewage system (6).
10	Refrigeration: none (0); spring house or cellar (2); ice (4); electric or gas (6).
11	Ironing facilities: none (0); flat (2); fuel (4); electric (6).
12	Room combination: separate living room, dining room, kitchen and bedroom (6); separate bedroom, dining room combined with living room or kitchen (4); other combinations (0).
13	Exterior paint: none (0); whitewash (2); cracked or checked paint (4); unchecked paint (6).
14	Lighting system: candles (0); kerosene (1); mantle lamps (2); gas (3); electricity (6).
15	Telephone in house: yes (5); no (1).
16	Inside wall material: uncovered (0); paper (1); unmatched wood (2); matched wood (3); wall board (5); broken plaster (4); unbroken plaster (6).
17	Wall decoration: none (0); whitewash (2); kalsomine (4); torn wall paper (3); untorn paper (5); paint or decorative plaster (6).
18	Basement: none (0); part, dirt (2); full, dirt (3); part, cement (5); full, cement (6).
19	Kind of cook stove: fireplace (0); makeshift stove (1); wood-coal range (3); oil or gasoline (4); gas (6); electricity (6); other (3).
20	Room per person in winter: 0–.4 (0); .5–.9 (1); 1.0–1.4 (2); 1.5–1.9 (3); 2.0–2.4 (4); 2.5–2.9 (5); 3.0 and over (6).
21	Lawn and plantings: lawns and plantings (6); lawns or plantings (3); neither lawns nor plantings (0).
22	Water source: open stream (0); dug well (2); drilled well (4); cistern or enclosed spring (5); public system (6).
23	Condition of window screens: none (0); broken (3); unbroken (6).
24	Structural soundness of house: sagging or rotting (1); solid (5).
25	Roof material: paper (0); sheet iron or tin (2); wood shingles (4); composition shingles (5); tile or slate (6).
26	Floor space per person: 0–99 feet (0); 100–199 feet (1); 200–299 feet (2); 300–399 feet (3); 400–499 feet (4); 500–599 feet (5); 600 feet and over (6).
27	Exterior wall material: log (0); battened or tar-paper-covered boards (2); lapped-planed siding or shingles (4); stucco (5); concrete, stone, brick or cinder blocks (6).
28	Distance to services: under 1 mile (6); 1.0–1.9 miles (5); 2.0–2.9 miles (4); 3.0–3.9 miles (3); 4.0–4.9 miles (2); 5.0–5.9 miles (1); 6.0 miles or more (0).
29	Condition of steps: none (0); broken boards (1); loose or insecure materials (3); solid materials (6).
30	Window coverings: none (0); curtains or blinds (3); blinds and drapes and/or curtains (6).

included in the abbreviated scales was the diagnostic ability of each item as determined by Method *C*. More specifically, the 10 items used in the shortest scale (the first 10 in Table II) are the 10 which had highest average "*t*" values (Table I). To make the scale of 20 items the highest 20 items in Table I were used. Similarly, the first 30 items comprised the longest of the three abbreviated scales, except that the item ranking 31 was substituted for item 24 which was a difficult item for which to obtain information. The score for a house is the arithmetic average of the 10, 20 or 30 items, depending upon which scale is being used.

The *validity* of the abbreviated scales is indicated in the following facts: (a) Pearsonian correlation coefficients of each abbreviated scale and the longer scale of 57 items (Method *A*) were as follows:

$$r_{57.10} = .89; \qquad r_{57.20} = .94; \qquad r_{57.30} = .97$$

(b) The validity of the weights used in Method *A* (the source of the weights in the abbreviated scales) is indicated in the high intercorrelations of methods *A*, *B*, *C* and *D*.[6]

The *reliability* of the abbreviated scales is indicated in the following facts: (a) high internal consistency of the component items since they were selected as the most diagnostic items according to Method *C* and since all of the 57 items from which the weights were made by Method *A* showed high internal consistency. More specifically, a split-half test of the 57 items as weighted by Method *A* resulted in $r = .85 \pm .14$ and $\bar{r}$ (Spearman-Brown) $= .92$, and intercorrelation coefficients of scale *A* and sub-indices[7] of sanitation (*G*), safety (*H*), labor-saving devices (*I*), electrical equipment (*J*), and space (*K*) were as follows:

$r_{AG} = .90 \pm .04;$	$r_{GH} = .75 \pm .04;$	$r_{HI} = .66 \pm .04$
$r_{AH} = .79 \pm .04;$	$r_{GI} = .94 \pm .04;$	$r_{HJ} = .61 \pm .04$
$r_{AI} = .86 \pm .04;$	$r_{GJ} = .83 \pm .04;$	$r_{HK} = .31 \pm .04$
$r_{AJ} = .77 \pm .04;$	$r_{GK} = .34 \pm .04;$	$r_{IJ} = .89 \pm .04$
$r_{AK} = .52 \pm .04;$	$r_{JK} = .16 \pm .04;$	$r_{IK} = .26 \pm .04$

[6] Another test of the validity of scale *A* was made by calculating a coefficient of correlation between the scores of that scale and scores obtained by ratings made from photographs of the same houses in which 20 selected raters sorted 70 photographs of houses into seven piles representing temporary scores ranging from zero to six with the mean value of the 20 ratings becoming the final photo score of each house. In these ratings a test of reliability of the raters was made by including two photographs of seven of the houses (viewed from different perspectives). The ratings of those raters who proved to be reliable were used in determination of the final photo scores. The coefficient of correlation (Pearsonian *r*) of Scale *A* and the photo scores was $r = .92$ with a sampling error of .16 ($E_{r11} + E_{r10}$).

[7] There was some overlapping of the components included in sub-indices *G*, *H*, *I*, *J* and no correction was made for the spuriousness thereby introduced. The amount of spuriousness is, however, very

Also the mean housing scores on scale *A* for 20 matched families interviewed by two different interviewers were not significantly different.

$$M_1 = 4.23; \qquad M_2 = 4.25$$

(b) Reliability coefficients of the abbreviated scores by split-half tests were as follows (sampling error was .14):

$$r_{10a.10b} = .82; \qquad r_{20a.20b} = .86; \qquad r_{30a.30b} = .84$$

which when corrected by Spearman-Brown formula were:

$$\bar{r}_{10a.10b} = .90; \qquad \bar{r}_{20a.20b} = .92; \qquad \bar{r}_{30a.30b} = .91$$

(c) Questionnaires which were administered to 1,641 school children in the communities in which the interviews were made indicated that the interview data were recorded with reasonable accuracy.

To expedite comparison of subsequent data that may be obtained by use of the abbreviated scales with the scores obtained in the present study, decile and quartile values of abbreviated scales of varying lengths are shown in Table III.

TABLE III
DECILE AND QUARTILE VALUES OF ABBREVIATED HOUSING SCALES

Decile and quartile	Abbreviated scale		
	10 items	20 items	30 items
First decile	1.0	2.2	2.4
Second decile	1.3	2.5	3.0
First quartile	1.5	2.7	3.2
Third decile	1.8	2.9	3.3
Fourth decile	2.3	3.2	3.7
Fifth decile (Q_2, Md.)	3.0	3.6	4.0
Sixth decile	3.8	4.1	4.4
Seventh decile	4.3	4.5	4.7
Third quartile	4.5	4.7	4.8
Eighth decile	4.7	5.0	4.9
Ninth decile	5.1	5.3	5.2

In conclusion, it appears that the above abbreviated scales comprised of 10, 20 or 30 items may be used to measure housing in rural Pennsylvania with reasonable validity and reliability. Since the selection of items for the abbreviated scales was based on diagnostic ability of the items, very little validity and reliability are sacrificed by reduc-

small. *G* included items 1, 2, 3, 4, 5, 9, 10, 11, 14, 18, 19, 22, 23, 24, 37, 40, 44, 45, 47, 48, 50, 51, 52, 54; *H* included items 4, 14, 16, 22, 23, 25, 26, 28, 30, 33, 40, 42, 44, 52, 53, 54, 55; *I* included items 1, 2, 3, 4, 5, 9, 10, 11, 14, 15, 19, 37, 48, 49; *J* included items 3, 10, 11, 14, 15, 19, 34, 37, 49; and *K* included items 8, 12, 20, 27, 35, 36, 45.

ing the number of items to 10. Standardization of the scales awaits further testing.

The research described in this article suggests possibilities of constructing scales for other populations. Similar work could be done with secondary data from the *1940 Census of Housing*. Another statistical problem that, according to the above analysis, may deserve further attention is the comparative usefulness of *a priori* weights in constructing composite indices and weights assigned by other means.

COORDINATING PRODUCTION FOR WAR*

By Shelby Cullom Davis

The classic nightmare at our auto plants used to be the spectacle of a four-door body arriving at the final assembly line just in time to be lowered on a chassis built for two. The nightmare was the worse if the body was red and the chassis green. But such spectres practically never occurred. The reason: coordinated production. Every part, every component in the right place at the right time—a constant flow of materials through the plant and resulting economies in the use of materials, warehousing space, and dollars to finance inventory. Coordination in the manufacturing process meant economy of facilities, too. All departments had a relatively even capacity and some were not idle, further tying up investment and making for unbalance.

What has been urgently needed in the American war economy is just such coordinated production. During the spring and summer of 1943 it has been slowly emerging—a new phase in the war production effort of World War II, an immensely valuable phase whose rewards are measured in the thousands of additional airplanes, guns, tanks, ships and other items which hasten the day of ultimate victory.

Statisticians, both in Washington and in the field, have played an invaluable part in bringing about this coordinated production and ensuring its success through insistence upon accurate and realistic production schedules. Although it is still too early to point, chapter and verse, to the statisticians who fought through the "Battle of Washington" to achieve these ends, no one can deny the contribution which statistics has made in forecasting the bottlenecks and freeing the economy from the chaos which frequently threatened.

Three years ago, in the days of the National Defense Advisory Commission which was set up after the fall of France in 1940, the great bottleneck was machine tools. The term "bottleneck" became an everyday part of the vernacular. Now most of these machine tools are in place, and are hungrily devouring all kinds of materials. Other bottlenecks, however, threatened to become so numerous that complete coordination of production, as in the automobile plants, became imperative. That the war production cycle is fast moving toward its final phase, indeed, is indicated by the fact that machine tool backlogs have

* A revised version, brought up to date, of a paper presented by Mr. Davis at a meeting of the Industrial Statistics Group of the New York Chapter on February 17, 1943. The author at that time was Chief Statistician of Region II (New York State—Northern New Jersey) of the War Production Board; now he occupies a similar position for the Smaller War Plants Corporation.

for some time been declining and many machine tool makers are starkly facing the problem of conversion to other war work.

Coordination of production is the third and final stage of our war economy. The first stage was the make-ready stage. The emphasis was upon more and ever more machine tools and the construction of new plants, such as the Chrysler Tank Arsenal. Our arsenal for democracy was superimposed upon the structure of an already booming civilian economy.

The second phase—conversion—which occurred shortly after Pearl Harbor, was dramatized by the shutdown of the automobile industry in February 1942. L and M Orders limited the production of goods to a certain level, or eliminated them entirely. The main purpose of the economy became war. Contracts were fairly shoveled out by the government procurement agencies. The production curve climbed steadily. Then it began to falter. The answer was, in part, materials shortages and the problems of scheduling as these shortages increased. More steel, copper and aluminum were being produced than ever before, but not enough.

So the next big job was brought to focus: achieving maximum sustained production by helping to get every plant on an approved schedule within a precisely balanced over-all program. Materials and other resources had to be budgeted and set aside and allocated for the specific purpose of producing the greatest possible amount of the things needed most by the United Nations at any given time.

The normal laws of supply and demand had long since become inoperative, because there was no ceiling to demand. The Nation's ability to produce, which had never before been tested, was definitely limited. The preference rating system, designed to insure that urgent production got materials ahead of less urgent, bogged down. Priority certificates, which authorized their holders to receive equipment or materials, became known as mere "hunting licenses"—for frequently more certificates were outstanding than the equipment or material to honor them.

The Production Requirements Plan, a big improvement, was set up in the late spring of 1942 as a means of allocating materials on the basis of the quarterly needs of the various manufacturers. It proved inadequate principally because it did not compel the total program to be kept within ability to produce. And it didn't make sure that some components wouldn't be manufactured at the expense of others. The patriotic manufacturer, for example, who boasted his production of machine guns was 60 per cent ahead of schedule, had unwittingly

caused some other manufacturer of an equally important product to be behind schedule. Further, some manufacturers, determined to keep their plants on schedule, ordered more materials than they needed before they needed them. The temptation to over-order, in general, proved too strong in too many instances. As a result, materials piled up in inventory, instead of flowing swiftly through the country's machine shops and factories.

Meanwhile, individual delivery schedules were being set on all prime contracts awarded by the Army, Navy or Maritime Commission. When the Navy ordered a warship, it specified the completion date and a time schedule leading up to fulfillment of that completion date. The same for tanks, machine guns or airplanes. But no over-all authority existed to supervise all scheduling. No one saw, first of all, that the scheduling was possible in terms of materials and facilities available, and secondly, that the scheduling was balanced from the point of view of military necessities. Furthermore, schedules of production more often than not were too optimistic and represented the wishes of the procurement agencies rather than an accurate, statistical measure of their fulfillment. And since the procurement agencies awarded all the contracts, they made up all the production schedules on prime contracts. Schedules on subcontracts were, of course, made by the individual prime contractors, but they were usually too optimistic also and frequently called for deliveries long before they were actually needed.

The Army-Navy Munitions Board did attempt to act as a kind of umpire between the two greatest sources of materials demand, the Army and Navy, but its efforts were only partially successful. Clearly a third party, representing the country as a whole and acting as an objective arbiter, was essential.

By the autumn of 1942, it had become apparent that production throughout most of 1943 would lack a tight and well developed system of distributing materials. The Production Requirements Plan would end in the first quarter, and the new Controlled Materials Plan (CMP), which aimed at tightening control of materials through allocating the exact amounts of steel, copper and aluminum needed for end products, would be introduced in the second, but it would probably not become effective until the third. It was felt that the coming months would witness a general excess of fabricating facilities while raw materials would act as the general limiting factor. Nevertheless, many of those in authority believed that important fabricating bottlenecks retarding production of components and end items would arise. Hence, such bottleneck items as compressors, valves, bearings, generators,

Diesel engines and certain machine tools should be given special attention. Furthermore, while the schedules were being brought in line with fabricating capacity and raw materials, they should be reviewed concurrently in relation to manpower resources.

Although production had advanced steadily throughout 1942, there was increasing evidence of widespread imbalance in the production program. Production of many end products had run far ahead of schedule, while for others it had fallen far behind. Among complementary items such as guns and radios in relation to tanks and airplanes, and ammunition in relation to weapons a similar situation prevailed. So long as an adequate supply of raw materials and other resources existed, this imbalanced production was not serious. But with machine tools, and labor growing scarcer, needless hoarding of raw materials in inventories of components or end products seriously aggravated the situation.

In the case of aircraft, for example, schedules were optimistic, partly to set high goals as an incentive. Certain branches of the Services presented forecasts of production which were not attained by as much as 50 per cent month after month. Although it might have been desirable to keep the schedules high in order to serve as incentives, the excess of forecasts over production had been too great to achieve this end. Ground Army equipment production was understood to be falling increasingly behind the schedules, particularly such difficult items as self-propelled artillery. Students of the problem thought that each manufacturer or procurement agency should schedule out production of end items, parts and components on the basis of realistic production probabilities of industrial plants in existence or being constructed.

As the new Controlled Materials Plan, previously mentioned, was being born, under the guidance of Ferdinand Eberstadt, WPB Vice-Chairman, it seemed obvious that the flow of materials could not be efficient and successful if the schedules which had already proven so erroneous were the basis for the material requests of the Claimant Agencies. Likewise, strategic decisions certainly could not be based upon the given schedules which past performance had revealed to be so substantially in error.

On December 8, 1942, the WPB Industry Divisions were asked by Mr. Ernest Kanzler, at the request of the Military Committee under the chairmanship of General Lucius Clay, to get from Claimant Agencies their requirements for common components. Only Rubber and one other agency were able to reply, and they only in part. If the Claimant Agencies, such as Army, Navy, Maritime, or Lend-Lease, did not have a thorough grasp of these vital facts, who would? Here was

proof positive that a gaping hole of ignorance had been opened up which badly needed to be plugged by realistic statistics and coordinated production.

On December 31, Mr. Ralph Cordiner, whose Scheduling Committee replaced this Military Committee, asked the Divisions concerned to call in the manufacturers of the critical components and appraise the situation. This developed (1) a shortage of materials and (2) a shortage of orders. With Mr. Eberstadt's cooperation, the necessary materials were arranged for.

The order shortages were more difficult. One industry reported on January 11, 1943, that its unfilled orders for the second quarter of 1943 were only 40 per cent of its production in the fourth quarter of 1942. Suppliers of critical components, facing declining backlogs of unfilled orders, were reluctant to step up current production rates still further, even if requirement estimates of the Services showed needs taxing capacity for the year ahead. During January an attempt was made to have orders placed at once for critical components, before February 6 for delivery to June 30 and before March 1 for delivery in 1943—but the furor which this circular letter of January 28 to several thousand builders created, showed the need. In the case of one prominent manufacturer of ammunition components, firm orders extended only through February.

Donald M. Nelson, Chairman of the War Production Board, was thoroughly aware of the growing need for scheduling and of the fact that actual war production in most categories fell short of scheduled production throughout most of 1942, and increasingly so as the year advanced. In a report to President Roosevelt, he cited the fact that during the first quarter of the year actual production of two-engine medium bombers was 137 per cent of the forecast for the first quarter made on January 1; the corresponding percentage for the second quarter was 95; for the third 84; and for the fourth 72. Actual production, however, had increased almost constantly. The same was true of many other items.

There were several explanations for this falling behind schedule, according to Mr. Nelson:

1. The objectives were too high.
2. As critical resources became scarcer, schedules were boosted in order to strengthen the claim of the competing services on such resources.
3. The coordination of the country's resources in an attempt to meet these schedules was insufficiently rigorous.

4. The schedules were not subjected to a centralized review and control. This decentralization existed not only among, but also within, agencies.

Had schedules been prepared realistically, it would have been obvious early in 1942 that the objectives were out of line with resources and the goals could have been brought down to the limits of feasibility, thereby requiring early in the year a complete review of the entire program. Schedules were "seriously defective" as analytically useful predictions of war output, concluded Mr. Nelson.

Scientific scheduling actually began when the Production Scheduling Bureau of WPB examined the outstanding orders for common critical components in February and March, 1943, and with the aid of statisticians, began to schedule their production. In many cases this involved spreading the work. So-called task forces of industrialists, consisting of advisory scheduling committees attached to WPB industry divisions, made recommendations on transfers of orders for critical common components from firms having too large a backlog to others without enough work to go around on a continuous 1943 production schedule.

Attention was concentrated upon production of gears, valves, Diesel and gasoline engines, crankshafts, compressors, pumps, heat exchangers, welding rods and electrodes, electric motors, starters and generators, boilers, vacuum tubes and control instruments.

Many examples of thoroughly unscientific scheduling were found. One large builder of direct current motors, equipped to produce about 220 per month, was being called upon to ship more than 1500 within less than 30 days. At the same time a smaller manufacturer, with a capacity of more than 100, was being called upon to turn out only 60 a month.

The General Scheduling Order, M-293, issued in March, required all manufacturers of 47 major groups of components to submit monthly operating reports covering backlogs, new orders, deliveries, cancellations. M-293 provided the means of closing the gap between the Controlled Materials Plan, covering allocation of raw materials to manufacturers, and the delivery on schedule of the finished munitions. In effect, it did for critical common components what CMP did for raw materials—insured their delivery at the right place at the right time.

At a staff meeting shortly after WPB had assumed responsibility for over-all scheduling, Charles E. Wilson, Executive Vice Chairman of WPB, stated that a well-coordinated war production program would increase over-all production by something like 10 per cent; but that it could increase production of critical items, such as the five then current

"musts" (escort vessels, 100 per cent octane gasoline, synthetic rubber, airplanes, and merchant ships) by as much as 25 to 30 per cent.

It is difficult, if not impossible, to know how much over-all gain in production has been achieved. Too many other factors, such as the normal production increase previously scheduled for 1943 or the growing tightness of labor supply, have intervened. It is correct to state, however, that many individual bottlenecks have been eliminated and threatened breakdowns in production averted. A three months' delay in the opening of a lens-making plant was avoided by persuading the management to accept delivery of compressors from a smaller, less widely known company. The delivery of heat exchangers for a large synthetic rubber plant was pushed forward three months by transferring $350,000 of orders from an overloaded producer to one operating below capacity.

Individual manufacturers are enthusiastic about the scheduling program, which they feel has brought about at least a reasonable semblance of order from chaos. A small company in northern New Jersey is a typical example. Before scheduling went into effect, this producer of electric motors (both alternating and direct current, from fractional to 200 h.p.) was frequently able to ship monthly only as much as one-third of what was desired. Furthermore, it had been common practice of the Claimant Agency and the prime contractor and, if one existed, the first tier subcontractor, each to advance the date on which the electric motors were required from the company by several months. Thus, company officials often suspected—and it was all too frequently true—that some of the motors on which it was lavishing herculean production efforts might repose in inventory at the point of final assembly of the finished munitions product for as much as six months. On the other hand, tardiness in delivery on another order might actually impede the war program.

With heavy but attainable schedules now in effect, the company has in turn been able to install an efficient internal scheduling system which insures that its monthly schedules are closely adhered to. In June, the first month of scientific scheduling, the company shipped 92 per cent of its commitments, a tremendous increase over its previous performance. Wide publicity was given in the plant to the production schedules for the twelve various types of motors. A large sign indicated, where everyone could see, the scheduled production for each type of motor, the shipments each week, and the number of units "to go" during the remainder of the month.

The officials of this relatively small plant predict scheduling will still

further increase production by 25 per cent within a few months. Other examples, involving larger companies, could also be cited.

With production of some critical munition items scheduled to increase as much as 50 per cent during 1944, the need for the most efficient operation possible—as if America were one gigantic automobile plant, where scheduling has long since been reduced to a science—is obvious. Only through the most rigorous scheduling, aided and abetted by the Nation's statisticians, will America be geared to produce just what is needed, when it is needed—not too little and too late—but enough, and on time.

STATISTICS FOR WAGE STABILIZATION

By Robert J. Myers and Harry Ober
U. S. Bureau of Labor Statistics

The administration of the Federal program for the stabilization of wages has required the accumulation of an unprecedented volume of detailed and systematic wage information. The primary source of such information is the Occupational Wage Rate Project, originated early in 1943 by the Bureau of Labor Statistics[1] and financed in part by the National War Labor Board. This project not only serves as a useful instrument of wartime economic control, but also provides a type of wage statistics long needed in collective bargaining.

The wage statistics generally available from public sources are designed primarily for other purposes and are too broad in scope and too general in nature for effective use in wage stabilization or the settlement of wage disputes. For these purposes, wage statistics must be available by individual occupation and by particular locality. The collection of such data is laborious and expensive, and in normal times has been considered beyond the means of public agencies. The lack of impartial statistics on occupational wages has seriously impeded the peaceful negotiation of wage disputes.

On several occasions in the past the Federal Government has undertaken to provide occupational wage statistics for special purposes. Unfortunately, the usefulness of these statistics has been considerably reduced due to delay in determining their need, and to the length of time required to plan and accomplish their collection. Thus, the most ambitious study of occupational wages in World War I, undertaken at the request of the War Industries Board, was not started until the summer of 1918 and did not result in a preliminary report until the spring of 1920. Special wage studies undertaken for the National Recovery Administration, although yielding early and useful results, again demonstrated that detailed and accurate wage statistics cannot be produced overnight.

The outbreak of World War II found comparatively little informa-

[1] The Occupational Wage Rate Project herein described was developed under the general supervision of A. F. Hinrichs, Acting Commissioner of Labor Statistics, and N. Arnold Tolles, Chief of the Bureau's Working Conditions and Industrial Relations Branch. The project is operated by the Wage Analysis Division of the Branch. Robert J. Myers is Chief of this Division and Harry Ober is immediately in charge of the project. Lily Mary David, assistant supervisor of the project, has contributed substantially to its planning, while Toivo Kanninen and John F. Laciskey have been responsible for the preparation of the large number of required job patterns.

tion available from public[2] sources regarding wages in specific occupations and localities. General industry surveys by the Bureau of Labor Statistics provided information on earnings by occupation in a few industries, but these studies permitted analysis only by broad regions. Common-labor entrance rates were known for the largest cities, as were union wage rates for a few important jobs. A small amount of additional information was available in the files of various administrative agencies. For most industries, however, and particularly the nonmanufacturing industries, up-to-date occupational wage rates by individual city were largely or entirely lacking.[3]

The shortage of occupational wage data was first acutely felt in 1941 by the National Defense Mediation Board, which was responsible for the settlement of wage disputes but not for general wage stabilization. This Board found it necessary to initiate a number of brief, special studies for the purpose of comparing wage rates in disputant plants with those in comparable plants in the same industry and/or community. These were "tailor-made" studies, designed to fit the particular case involved and, in some instances, covering various other items in addition to wages. A number of special studies were also requested by the National War Labor Board, which succeeded the N.D.M.B. in January 1942. Much of the special research was done by the Bureau of Labor Statistics, which undertook approximately 75 studies for the Board during the first nine months of 1942.

With the launching of the stabilization program in October 1942, the number of special studies multiplied, many of them being used in connection with the review of voluntary wage-change proposals. In the first quarter of 1943, in fact, the Bureau completed more than 700 separate studies, although the majority of these involved little or no field investigation. Meantime the number of applications for approval of wage changes rose above 10,000 per month, and it became apparent that a larger, more systematic, and more economical organization for gathering wage data was required. In anticipation of the need for the systematic collection of occupational wage rates, plans for such a study

[2] Valuable material on wages in a few industries, particularly the metal-working industries, was obtainable from trade associations, individual companies, unions, and other private agencies. Some of this material had been collected from association members or other limited groups, and was not claimed to represent other segments of the industry. Material presented by interested parties, moreover, is often unacceptable to one of the participants in a wage dispute. Nevertheless, the wage material provided from private sources has served many purposes and has contributed substantially to the advancement of the wage-stabilization program.

[3] Apparently most other industrial nations were also lacking in occupational wage statistics. Canada, however, preceded the United States in the collection of such material. Occupational wage rates are available for important jobs in many Canadian cities and have been of considerable importance in administering the Canadian program for wage stabilization.

were made by the Bureau by the end of January 1943, and the project was launched in full scale early in April. Within the next six months the Occupational Wage Rate Project collected wage data from more than 60,000 manufacturing and nonmanufacturing establishments and transmitted summary reports covering more than 50,000 of these to the War Labor Board.

ESSENTIAL FEATURES OF OCCUPATIONAL WAGE STATISTICS

The characteristics of wage statistics for use in wage stabilization and in collective bargaining must, of course, be conditioned by the assumptions and policies of the administrative agency or the negotiating parties. It is of fundamental importance that wage determination in the United States is greatly influenced by common wage practice throughout the economy. Information regarding the prevailing level of wages is generally more useful than calculations of the cost of adequate budgets or similar measures. It is also highly significant that wage stabilization in this country has aimed at stabilizing wage rates, rather than weekly, monthly, or annual earnings.

Important, too, in its influence on wage statistics, is the unit (locality or industry) within which stabilization is to be achieved.[4] The importance attached to traditional wage differentials—for example, between jobbing and captive plants, or by sex or race of worker—is another factor that must be considered. It may be assumed, however, that policies of this type may change from time to time. Insofar as possible, the system of wage statistics should be flexible enough to accommodate itself to such changes.

In addition to those characteristics that reflect the particular policies of the administrative body, several important features would appear to be essential in almost any statistical system designed to determine prevailing wage rates for purposes of wage stabilization. First, the wage levels should be measured in terms of a stable and definite unit. Second, the data must be presented in extensive detail in order to reflect inter-area and inter-industry differences. Third, the wage statistics provided should be reasonably up-to-date. Fourth, in the interest of speed and economy, the statistical system should be simplified to the maximum extent consistent with the requirements of the administrative program. The methodological implications of these features are rather broad and justify brief discussion.

[4] In this respect public policy appears to have been considerably influenced by traditional practice. In shipbuilding, railroads, and certain other industries, local differences in general wage levels have been largely ignored. In the determination of wages in many industries, however, the locality approach has been dominant.

Unit of Measurement.—Statistics for wage stabilization and collective bargaining must permit frequent and direct comparisons of wages among groups of establishments, often across industry lines. It is essential, therefore, that a common unit of measurement be used. The most suitable unit is the hourly wage rate—or its equivalent, straight-time hourly earnings.

Weekly or monthly earnings are usually available, but these measures have been greatly influenced by variations in the number of hours of work, and hence constitute poor measures of the rate of remuneration. Even in nonmanufacturing industries, where salaries are commonly calculated by the week or half-month, differences in pay may reflect nothing more than differences in hours of work. Manufacturing establishments usually pay their workers by the hour or, in the case of "incentive workers," more or less in proportion to their production.

Incentive wage payment, whether consisting of straight piece rates or of a guaranteed base rate plus a bonus for output above a set norm, presents troublesome problems. Because of variations in the unit of output and in the characteristics of the different incentive plans, comparisons of the rates "per piece" are out of the question. For incentive workers, therefore, it is necessary to compute average hourly earnings over a period of time, and to substitute this average for the hourly rate obtained for time workers. For a variety of reasons, including the greater intensity of their work, incentive workers typically earn more per hour than time workers performing the same operations. Wherever practicable, therefore, the earnings of incentive workers should be tabulated separately from the rates of time workers.

Premium payments for overtime or late-shift work should not be permitted to distort wage-rate comparisons. Such payments should be considered as remuneration for special exertion or discomfort and dealt with separately from the rate problem. Christmas bonuses, vacation pay and similar items should also be considered separately and not combined with basic wage rates.

Wage rates are, of course, of little significance except in relation to the type of work performed. It is essential, therefore, that wage rates be collected and presented *by occupation.*[5] Some occupational groups, in fact, are so broad as to make further subdivision desirable.

Industry and Locality Boundaries.—Even for approximately the same type of work, wage rates differ substantially from industry to industry

[5] Weighted averages of the rates or earnings of all workers in a plant are sometimes compared during wage negotiations with similar averages for other plants. This device may be extremely misleading, however, because of differences in the "weight" of the various occupations. A plant which pays a higher rate than another in each separate occupation may show a lower plant average because of a difference in organization which permits the employment of relatively more unskilled workers.

and from locality to locality. The causes of such differences are complex and do not permit discussion here. The effect on wages is substantial, however, and warrants the use of fairly narrow boundaries in ascertaining levels of wages.

Some occupational classifications appear in essentially the same form in several industries, and workers in these jobs may transfer readily from one industry to another. In such occupations inter-industry differentials may be minor,[6] and the most important boundaries to observe in determining wage levels will probably be geographical. On the other hand, approximately the same levels of wages may prevail in neighboring cities over an extended period of time. In general, however, both geographical and industry limits are important considerations in wage statistics.

Even when the occupation, the industry, and the locality are the same, significant wage differences may be found because of other factors, such as differences in size of establishment, union status, method of wage payment, and so forth. The number of establishments in a given industry and locality rarely permits segregation of more than one or two of these factors in the same tabulation.

Timeliness.—It goes without saying that statistics for use in wage stabilization or wage negotiations should be relatively up-to-date. This means that unnecessary complications in the collection or tabulation of the wage data should be avoided, since these may delay the progress of the work.

In times of considerable wage movement, frequent repetition of wage studies will be essential. In addition to providing an up-to-date picture of prevailing wages, repetitive studies of occupational rates permit the construction of *indexes of wage rates*, which measure fairly accurately the effectiveness of the stabilization program.

Characteristic Industries and Key Jobs.—A complete occupational analysis of wages in all industries and in all communities would obviously involve great delay and enormous expense. The Dictionary of Occupational Titles, issued by the U. S. Employment Service, lists almost 20,000 different jobs, most of which are found in hundreds of communities. Fortunately, wage statistics for a small proportion of these jobs and in relatively few communities can provide an adequate statistical basis for collective bargaining and for official wage determination.

[6] Inter-industry wage differences may be substantial, however, even for nearly identical types of work in the same locality. Such differences often reflect variations in the regularity of employment, the safety or agreeableness of working conditions, and so forth. Such factors undoubtedly account in part for the high wages in shipbuilding and the construction industry as compared with the wages of more or less comparable workers in manufacturing.

In the first place, the wage levels of many communities are greatly influenced by wages in a small group of *characteristic industries*, which, with a few additions, provide a reliable pattern of wage structure. The characteristic industries vary, of course, by community. Opportunities for inter-industry transfers, supported by local tradition, help to maintain the relationship between wages in the minor trades and those in the leading industries. In many communities a survey of only 10 or 12 industries will cover more than half of all employed workers, while wages in the remaining industries may be closely tied to those that have been studied. Moreover, wage observations for the remaining industries may apply to too few workers to justify systematic analysis. Brief special studies will, of course, be necessary in some cases to determine existing relationships.

The study of all jobs in a given industry is even less justifiable than the study of all industries. The relationship of wage rates for the various occupations within a given industry shows considerable uniformity and, even when modified because of special circumstances in a particular establishment, may be almost as stable as the organization of production itself. The disturbance of occupational differentials is in most establishments a serious matter, which will not be undertaken lightly either by management or the union. Hence, the determination of wages in a few *key jobs*, although somewhat less enlightening than a complete occupational analysis of the industry, provides a sound basis for wage adjustment. Unquestionably the study of occupational wage rates in terms of key jobs facilitates analysis and permits great financial economies.

The key-job approach is supported by successful experience in collective bargaining and in wage determination. Many unions and employers have negotiated wages in this manner for years, adjusting wages in the intervening occupations automatically once the rates for key jobs are agreed upon. Job-evaluation experts depend heavily on key jobs in rationalizing company wage structure. Early experience under the Federal wage-stabilization program indicates that the key-job approach is not only suitable for purposes of wage statistics but may also serve successfully as a method of wage control.

It is obvious that other economies may also be realized without seriously reducing the value of the system of wage statistics. The study of prevailing wage rates in certain industries in large cities may safely be based on sample establishments. Many small communities may be omitted completely if other communities in the same region have been covered.

CHARACTERISTICS OF OCCUPATIONAL WAGE RATE PROJECT

The practicality of the features discussed above has been demonstrated by the experience of the Occupational Wage Rate Project. As a product of the war situation, this project was designed primarily to meet the needs of the War Labor Board. Both the plan and operation of the project have been modified by the day-to-day demands of the stabilization program. Yet uniformity, particularization, timeliness, and simplicity have remained among its major characteristics.

Data Collected.—The basic wage information obtained through the Occupational Wage Rate Project consists of hourly wage rates or (in the case of incentive workers) straight-time hourly earnings of experienced workers in specific occupations.[7] In order to eliminate the influence of late-shift premiums, the study of rates and earnings is usually confined to first-shift workers, although the total number of workers in the occupation is used for weighting purposes. The occupations studied are defined in writing, with separate descriptions in some cases for different grades of work within the job. Thus assemblers and many other workers are identified as grade A, grade B, or grade C. All wage figures are obtained directly from pay rolls or other basic records, and represent a typical pay-roll period (usually a week, two weeks, or a half-month) during the months of January, April, July, or October. All wage information intended for combination is, of course, obtained as of the same period.

In addition to the basic wage data, a considerable amount of supplementary information is secured, including type of product, total employment, provisions for overtime, late-shift work and vacations, the existence of union agreements, and other items. This material is of great value in classifying and interpreting the wage data.

The proper classification of workers by occupation and grade is, of course, of primary importance. Unfortunately, the classification systems of individual companies differ widely, and frequently forbid direct comparison. The designation of occupation and grade is consequently made independently of local practice and requires the careful attention of a trained field representative. Such field representatives discuss the duties of each group of workers with the labor manager, foreman, or other informed person, and frequently observe the actual performance of the work. The training of new field representatives has constituted one of the most difficult problems connected with the Occupational Wage Rate Project. Its accomplishment has required the cooperation

[7] Specimen copies of the field schedules used (forms OWR-1 and OWR-2) will be supplied on request to the Bureau of Labor Statistics.

of a number of trade schools, much special office instruction, and experienced supervision on the job. At one time more than 325 field workers were engaged in the collection of occupational wage rates for this project.

The tabulations produced by the Occupational Wage Rate Project for use by the War Labor Board,[8] a sample of which is reproduced herewith, are relatively simple in nature, but present substantial detail. For each key job in a covered industry and wage area they present the weighted average hourly wage rate and the range of rates for every establishment. Individual establishments are not identified, since cooperation in the project is on a voluntary basis and most companies are willing to report their wage rates only for use without identification. Insofar as is possible without revealing individual operations, however, the individual establishments are classified by size, unionization, and method of wage payment. Brief interpretative comments are transmitted with all tabulations, and special analyses are made on request or when obviously appropriate.

Scope.—As of September 1943, wage data have been collected from more than 400 separate localities, including virtually all cities of 25,000 population or more and a substantial number of smaller places. No attempt has been made to confine the collection of data within city limits, since similar wage levels often prevail in a large city and its environs, or in two or more neighboring communities. Places of less than 25,000 population have been covered largely on the basis of special administrative need, and with little regard for sampling theory.

In each wage area the intention has been to cover the characteristic industries. This plan has been adapted to the needs of the regional War Labor Boards, however, and as a result the representation of the characteristic industries has varied considerably from one wage area to another.[9] Nearly all manufacturing industries are represented in one or more wage areas, while the metal-working industries, important in war production, have been covered very generally. The inclusion of nonmanufacturing industries has been somewhat more uniform. Retail grocery stores, limited-price variety stores, auto-storage and repair establishments, and financial institutions have been covered in nearly

[8] During the early months of operation, all facilities of the project were needed to meet the requirements of the War Labor Board. In the late summer of 1943 a series of public releases was undertaken, to provide occupational wage rates by individual industry and locality. Arrangements were also made for the informal release of tabulated data to cooperating companies, unions, and other interested parties.

[9] A few industries, in which wages are determined on a national scale or which are subject to other special considerations, have been specifically excluded from the scope of this project for the time being. Prominent examples are coal mining, the railroads, iron and steel, shipbuilding, aircraft, and building construction. Several of these industries have been subject to recent intensive industry-wide surveys by the Bureau of Labor Statistics.

TABLE I

SAMPLE OF OCCUPATIONAL WAGE RATES
FOR ONE OCCUPATION

OWR-4

CONFIDENTIAL

OCCUPATIONAL RATES—PLANT SUMMARY

Industrial classification Machine Tools — Locality Chicago
Code No. 3541 — State Illinois
Occupation Engine-lathe operators
Grade A Male X Female — Pay-roll period April, 194.3

CLASS OF ESTABLISHMENT	Union-ization	Method of Wage Payment	Number in Occupation	Straight Time Hourly Earnings		
				Average	Minimum	Maximum
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total, 16 establishments	x x	x x x	46	$1.17	x x x	x x x
Total, 5 unionized establishments	x x	x x x	28	1.19	x x x	x x x
Total, 11 nonunionized establishments	x x	x x x	18	1.14	x x x	x x x
Total, time workers	x x	x x x	45	1.17	x x x	x x x
Total, incentive workers	x x	x x x	1	1.25	x x x	x x x
Individual establishments by size:						
Total, 4 large establishments (251 employees and over)	x	x	18	1.15	x	x
A	U	H	3	1.00	$0.95	$1.10
B	U	H	11	1.22	1.02	1.35
C	U	H	4	1.08	1.08	1.08
Total, 7 medium establishments (51 to 250 employees)	x	x	13	1.24	x	x
F	N	H	2	1.17	1.15	1.20
H	U	H	10	1.25	1.25	1.25
K	N	I	1	1.25	1.20	—
Total, 5 small establishments (9 to 50 employees)	x	x	15	1.12	x	x
L	N	H	5	1.22	1.20	1.25
M	N	H	5	1.09	1.05	1.10
N	N	H	1	1.15	1.15	1.15
P	N	H	4	1.04	.79	1.16

Note: The sample tabulation presented above is based on a study of 16 representative establishments manufacturing machine tools in the Chicago area. Six of these establishments (D, E, G, I, J, and O) employed no male, grade A, engine lathe operators whose duties were consistent with the Bureau's definition. All of the workers received straight hourly rates except the one worker in establishment K, who was paid on an incentive basis ("I"). The minimum rate shown in column 6 for this incentive worker is his *guaranteed* rate. Other figures appearing in columns 6 and 7 represent the minimum and maximum rates actually paid to individual experienced workers in the respective establishments.

The key jobs used to represent the machinery industries are listed in full in Table II. Tabulations similar to the above are prepared routinely for each key job by grade and sex. In addition, an industry summary (no example shown) is prepared in order to reveal the relationship among average wage rates in the various key jobs; this industry summary presents average rates for all key jobs for significant groups of plants, but does not give detail for individual establishments.

all wage areas, while a more or less standard group of seven additional nonmanufacturing industries has been covered in places of 100,000 population or more. Except in a few industries, establishments with fewer than nine wage earners have not been studied. Otherwise the

study has commonly included every establishment in each industry-area unit selected. Sampling of establishments has been practicable on some occasions.

Key Jobs.—Limitation of wage analysis to a few key jobs in each industry has contributed greatly to the simplicity and orderliness of the project and has hastened the processes of collection and tabulation. "Job patterns," consisting of groups of key jobs within individual industries, have been prepared for 120 separate industries. In preparing these patterns the Bureau has relied heavily on the assistance of labor unions, employers, and other groups, as well as on its own experienced field staff.

TABLE II

SAMPLE JOB PATTERN

(Subject to revision)

KEY JOBS IN THE MACHINERY INDUSTRIES (OTHER THAN ELECTRICAL)

Standard Industrial Code No. 35

1. *Maintenance*
   - Carpenters, Grade A and B
   - Electricians, Grade A and B
   - Machinists, Grade A and B
   - Millwrights, Grade A and B

2. *Supervision*
   - Working foremen, processing departments

3. *Processing*
   - Assemblers, bench, Grade A, B, and C
   - Drill-press operators, single spindle, Grade A, B, and C
   - Drill-press operators, multiple spindle, Grade A, B, and C
   - Engine-lathe operators, Grade A, B, and C
   - Milling-machine operators, Grade A, B, and C

3. *Processing (continued)*
   - Screw-machine operators, automatic, Grade A, B, and C
   - Screw-machine operators, hand, Grade A, B, and C
   - Tool and die makers, Grade A and B

4. *Inspection and Testing*
   - Inspectors, Grade A, B, and C

5. *Recording and Control*
   - Stock clerks

6. *Materials Movement*
   - Truck drivers I
   - Truckers, hand
   - Truckers, power

7. *Custodial*
   - Guards
   - Janitors
   - Watchmen

Note: The pattern for the machinery industries is often used in conjunction with other patterns—for example, the patterns for shops manufacturing stamped and pressed metal products, foundries, forge shops, and offices.

The job patterns for nonmanufacturing industries typically include only 10 to 15 key jobs, the selection of which presents few difficulties. Job patterns in manufacturing industries frequently include more than 20 key jobs, which may be selected from a total of 200 or more distinct occupations. Most job patterns cover 40 per cent or more of all wage earners.

In preparing job patterns for manufacturing industry, the labor force is regarded as consisting of seven functional categories: (1) maintenance

and repair of plant and equipment; (2) plant supervision; (3) processing; (4) inspection and testing of product; (5) recording and control of raw materials and the flow of work; (6) materials movement; and (7) custodial service. With rare exceptions, each of these categories is represented by one or more jobs in each industry. Thus all major functional groups are represented. The pattern for the machinery industries (other than electrical), presented below for illustrative purposes, includes 21 key jobs, most of which are subdivided by grade.

Except for the processing occupations, these categories are composed of jobs that recur from industry to industry. Thus maintenance jobs are found in nearly all industries, as are working foremen, timekeepers, hand truckers, janitors, and so forth. Such jobs provide a fairly dependable basis for inter-industry comparisons. Inspectors are also found in most industries but are specialized by product and not comparable from one industry to another.

The processing jobs vary widely from industry to industry, reflecting the variety of processes entailed in the manufacture of different products. Because most employees in manufacturing are engaged in processing and because a different set of processing jobs must be selected for almost every industry, these jobs constitute a large proportion of the individual occupations defined and studied in manufacturing industries. The following tabulation[10] indicates the number of different occupations (in manufacturing industries) for which definitions had been prepared by midsummer, 1943:

Maintenance	19
Supervision	2
Processing	634
Inspection	40
Recording	6
Materials movement	23
Custodial	4
Total	728

Within the seven functional categories, individual key jobs are selected by the application of five criteria: These are: (1) definiteness and clarity of the job; (2) numerical importance; (3) critical importance in the war effort; (4) traditional use in wage negotiations; and (5) representativeness of the entire range of wage levels in the industry.

Problems.—A number of troublesome problems have been encountered during the brief life of the Occupational Wage Rate Project. The difficulty of training several hundred field representatives in a period of a few weeks has been mentioned. Obviously the accuracy and consistency of the statistics produced are dependent upon the quality

[10] This tabulation is based on occupations and makes no allowance for subdivisions by skill grade.

of the field work. Another early problem was the difficulty of obtaining complete universes of establishments classified by city, number of employees, and current product.

The determination of prevailing wage rates in the small community continues to present difficulties. Cities of 25,000 population or less usually contain few manufacturing establishments and these are usually scattered among a number of industries. Tabulations for single industries consequently may yield somewhat unstable results, and may threaten disclosure of individual operations. The alternatives appear to be combination of the data—at least for certain occupations—for different industries within the locality or establishment of fairly broad wage areas including a number of small communities. Although neither of these alternatives is appealing, the latter appears generally to yield the more useful results. Grouping of industries, however, is sometimes unavoidable.

It is, of course, desirable to obtain wage data from all industries and communities as of the same period of time, but this goal is difficult of accomplishment. Assuming that a complete survey of all selected establishments is practicable only once annually,[11] it is apparent that use of the same pay-roll period must involve serious waste in the use of field staff after a peak period, or, if the collection of wage material is spread throughout the year, that much of the wage material will be many months old by the time it is collected. Under the circumstances, there is much to be said for the staggering of pay-roll dates by groups of related industries.

CONCLUSION

In summary, the outstanding features of the Occupational Wage Rate Project appear to be the following: (1) dependence on voluntary cooperation by employers; (2) use of current hourly wage rates as the basic unit of measurement; (3) employment of uniform, written definitions of occupations; (4) particularization of occupational rates by industry and locality; (5) collection of all data from basic records and by means of field visits by trained representatives; (6) limitation of observations primarily to major cities, and to characteristic industries and key jobs; and (7) presentation of findings in detailed but highly standardized form.

These features, although seemingly essential in view of the nature and scale of the stabilization program, have involved certain sacrifices. The selectivity of coverage, for example, has necessitated much inter-

[11] This does not suggest, of course, that more frequent studies in a small sample of plants may not be necessary for indicating trends of wage rates and for other special purposes.

polation by the administrative agency. The standardized form of presentation dictated by the scale of the project has tended to limit the opportunities for special handling of problem industries or areas. The segregation of wage data by individual industry has made necessary a certain amount of grouping of industry summaries for administrative use. Nevertheless, the project has constituted the chief source of information on prevailing wages and has undoubtedly played an important part in the stabilization program.

The adaptation of the project to the emergency needs of the War Labor Board has, of necessity, limited its usefulness for certain other purposes. Representation of the various industries and regions, for example, is by no means uniform, and the heavy demands of the regional Boards have temporarily impeded the broad distribution of the material and limited its general analysis.

In view of the origin of the project as an instrument of wartime control, its post-war future is uncertain. There is little doubt, however, that current information on occupational wage rates will be greatly needed in effecting the transfer of millions of workers from wartime to peacetime jobs. Moreover, the project provides the basis for a long-needed index of wage rates, to supplement present measures of trends in hourly and weekly earnings. Undoubtedly the greatest need for occupational wage rates, however, is for use in wage negotiations; detailed and impartial wage information can contribute substantially to the maintenance of industrial peace.

THE DISTRIBUTION OF DEPOSITS AND CURRENCY IN THE UNITED STATES, 1929–1939

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In spite of the plethora of statistical data gathered by government agencies and private institutions, there still remain certain serious gaps in the quantitative economic picture. One of these gaps is the lack of detailed information regarding the holdings of money, time deposits, and other liquid savings in the hands of various economic groups. Current information of this nature should help considerably in the adoption of adequate fiscal policies and would contribute to the advancement of monetary theory.

The need for such data is well recognized and some steps are now being taken to obtain them, at least partially, at regular intervals.[1] But little of such information has been available for the period preceding the present war. It is the purpose of this note to present certain data on the distribution of deposits and currency during that period. The accompanying tables furnish an approximation of the amounts of deposits and currency for the years 1929–1939 in the categories indicated.

These estimates are an extension of a study initiated by the Federal Reserve Board.[2] The principal procedures followed in developing the estimates are described in the *Federal Reserve Bulletin* for October 1939. However, certain modifications of the original procedures have been deemed desirable. The most important of these are:

(1) Adjustments for demand deposits were made only for items in transit between banks, whereas the Federal Reserve Board study made an additional adjustment for items in transit between depositors. Without the second adjustment the latter "float" becomes part of the unclassified holdings.

(2) The holdings of corporations in demand deposits, time deposits, and currency were estimated on the basis of the proportion of these components of total cash in the various industries as found by the Federal Reserve Board in its study of large deposit accounts for 1933

[1] The Federal Reserve Board, in cooperation with the reserve banks, is planning to survey a considerable number of banks every six months to classify deposits by type of holder. See *Federal Reserve Bulletin*, August 1943. The Securities and Exchange Commission's periodic releases giving estimates of the components of individual savings are also of value in meeting this need.

[2] The procedures used in the Federal Reserve Board study were developed by Martin Krost, who compiled estimates for the end of 1933 and 1935. Lauchlin Currie presented a paper based on these estimates before the American Statistical Association in December 1937 (published in this Journal for June 1938). Haskell Wald, using the techniques developed in the earlier study, made estimates for the end of 1936 and 1937, published in the *Federal Reserve Bulletin* for October 1939 and May 1940, respectively.

and 1935. The proportions prevailing in 1933 were applied to cash holdings in 1929, 1930, 1931, 1932, and 1933. The 1935 proportions were used for the years 1935, 1936, 1937, 1938, and 1939. For the year 1934, the averages of 1933 and 1935 were used.

(3) Holdings of security brokers, assumed to be demand deposits only, were estimated by the Federal Reserve Board for 1933 and 1935 through 1939. The approximate relationship during these years between brokers' borrowings by New York Stock Exchange members and their money holdings was the basis for deriving the estimates of the earlier years.

(4) Deposits of banks' trust departments have been included with the unclassified group. This was done because estimates of these deposits, based on the proportion of such deposits in national banks to similar deposits in insured banks in May 1936, become quite unreliable for the period prior to 1933 when the number of national banks exercising trust powers was considerably larger.

(5) Deposits of other public bodies were estimated through 1935 on the basis of the percentage change between June and December of such deposits in Federal Reserve member banks, applied to similar deposits in all banks on June 30. From 1936 such deposits are reported by the Comptroller of the Currency for year-end dates.

The reliability of the data varies from those figures regularly reported, such as United States Treasury holdings, to estimates based on rather meager evidence, such as holdings of security brokers. Reliability likewise varies for the different years depending on the adequacy of the basic data from which the estimates were derived. On the whole, the data for the distribution of deposits and currency, except for the holdings of non-corporate enterprises and security brokers, present a satisfactory degree of reliability. The distributions of demand deposits and currency, and demand deposits only, become less accurate since they require the deduction of estimates of time deposits, and time deposits and currency, respectively, for the various holders. Nevertheless, even the figures whose accuracy may be questioned should be decidedly useful for general indications of the various magnitudes.

A detailed analysis of the underlying reasons for the changes in the money supply (demand deposits and currency) and the shifts in its distribution would shed a great deal of light on the economic tendencies in operation during the period. Such an analysis of the data is beyond the scope of this note, but a few significant changes indicated by the figures for the money supply and the important economic groups of money holders, Table I, may be noted.

Changes in the magnitude of the money supply during the decade of

TABLE I

THE DISTRIBUTION OF DEMAND DEPOSITS AND CURRENCY BY TYPE OF HOLDER

(amounts in millions of dollars—end of year figures)

	1929		1930		1931		1932		1933		1934		1935		1936		1937		1938		1939	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
*Total**	*27,290*	*100.0*	*25,540*	*100.0*	*23,000*	*100.0*	*21,270*	*100.0*	*20,980*	*100.0*	*25,180*	*100.0*	*29,060*	*100.0*	*33,860*	*100.0*	*31,540*	*100.0*	*34,360*	*100.0*	*38,820*	*100.0*
Business—total	*8,780*	*32.2*	*8,570*	*33.5*	*7,050*	*30.7*	*6,900*	*32.4*	*6,470*	*30.9*	*7,240*	*28.8*	*7,850*	*27.0*	*8,860*	*27.0*	*8,080*	*25.8*	*9,070*	*26.4*	*9,950*	*25.6*
Corporations engaged in:																						
Manufacturing, mining, and construction	3,800	14.0	3,820	14.9	3,260	14.2	3,120	14.7	2,900	13.8	3,030	12.0	3,530	12.1	3,800	11.6	3,550	11.3	4,200	12.3	4,800	12.3
Transportation and public utilities	1,240	4.9	1,390	5.4	1,070	4.7	1,090	5.1	1,080	5.2	1,120	4.5	1,140	3.9	1,450	4.4	1,080	3.5	1,320	3.8	1,450	3.7
Trade, service, agriculture, and miscellaneous	1,730	6.3	1,550	6.1	1,270	5.5	1,270	6.0	1,200	5.7	1,530	6.1	1,560	5.4	1,790	5.5	1,690	5.4	1,730	5.0	1,780	4.6
Non-corporate enterprises†	1,910	7.0	1,810	7.1	1,450	6.3	1,420	6.6	1,290	6.2	1,570	6.2	1,610	5.6	1,820	5.5	1,750	5.6	1,820	5.3	1,920	5.0
Finance—total	*5,570*	*20.4*	*4,480*	*17.5*	*2,930*	*12.7*	*2,350*	*11.0*	*2,020*	*9.6*	*2,820*	*11.2*	*3,960*	*13.6*	*4,230*	*12.5*	*4,160*	*13.2*	*4,790*	*13.9*	*6,360*	*16.4*
Corporations engaged in:																						
Insurance	400	1.5	370	1.4	350	1.5	470	2.2	590	2.8	760	3.0	940	3.2	990	3.0	930	3.0	1,060	3.1	1,310	3.4
Other finance	2,050	7.5	1,900	7.4	1,240	5.4	1,050	5.0	860	4.1	1,350	5.4	1,770	6.1	1,630	4.9	1,550	4.9	1,740	5.1	1,960	5.0
Non-corporate:																						
Security brokers	1,820	6.7	1,010	4.0	370	1.6	100	.5	200	1.0	260	1.0	200	.7	300	.9	280	.9	240	.7	260	.7
Foreign banks	550	2.0	550	2.2	480	2.1	260	1.2	130	.6	170	.6	470	1.6	530	1.6	630	2.0	700	2.0	1,150	3.0
Other foreigners‡	750	2.7	590	2.3	490	2.1	450	2.1	240	1.1	290	1.2	570	2.0	780	2.4	780	2.5	1,050	3.0	1,680	4.3
Public bodies—total	*1,890*	*6.9*	*1,970*	*7.7*	*2,060*	*8.9*	*1,810*	*8.5*	*2,550*	*12.2*	*4,080*	*16.2*	*4,170*	*14.3*	*4,170*	*12.7*	*3,620*	*11.6*	*4,820*	*14.0*	*4,420*	*11.4*
United States Treasury	190	.7	330	1.3	520	2.3	520	2.4	1,020	4.9	1,840	7.3	1,450	5.0	1,240	3.8	970	3.1	1,820	5.3	1,480	3.8
Other public bodies	1,700	6.2	1,640	6.4	1,530	6.6	1,290	6.1	1,530	7.3	2,240	8.9	2,710	9.3	2,930	8.9	2,650	8.5	3,000	8.7	2,930	7.6
Unclassified—balances of individual, nod-profit organizations, banks' trust departments, etc.	*11,060*	*40.5*	*10,580*	*41.5*	*10,970*	*47.7*	*10,250*	*48.1*	*9,940*	*47.3*	*11,030*	*43.8*	*15,110*	*45.1*	*15,600*	*47.5*	*15,480*	*49.3*	*15,690*	*45.7*	*18,100*	*46.6*

* Demand deposits are adjusted for items in process of collection by banks and exclude domestic interbank deposits.

† Excludes professional service, agriculture, finance, transportation, and public utilities.

‡ Includes foreign bank deposits with non-member banks.

Note: Amounts are rounded and will not necessarily add up to totals.

‡ Includes foreign bank deposits with non-member banks.
Note: Amounts are rounded and will not necessarily add up to totals.

TABLE II

THE DISTRIBUTION OF TOTAL DEPOSITS AND CURRENCY BY TYPE OF HOLDER

(millions of dollars—end of year figures)

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
*Total**	*55,470*	*54,160*	*48,990*	*45,710*	*42,770*	*48,370*	*53,290*	*58,260*	*57,600*	*60,740*	*65,880*
Business—total	*10,230*	*10,000*	*8,230*	*8,050*	*7,560*	*8,080*	*8,420*	*9,540*	*8,670*	*9,740*	*10,700*
Corporations engaged in:											
Manufacturing, mining, and construction	4,560	4,580	3,910	3,750	3,470	3,450	3,810	4,110	3,840	4,540	5,190
Transportation and public utilities	1,680	1,740	1,350	1,360	1,360	1,320	1,260	1,610	1,200	1,460	1,600
Trade, service, agriculture, and miscellaneous	1,850	1,660	1,360	1,370	1,290	1,620	1,650	1,689	1,790	1,820	1,880
Non-corporate enterprises†	2,140	2,010	1,610	1,570	1,430	1,690	1,700	1,930	1,840	1,920	2,030
Finance—total	*6,200*	*5,160*	*3,170*	*2,630*	*2,240*	*3,100*	*4,260*	*4,630*	*4,470*	*5,130*	*6,760*
Corporations engaged in:											
Insurance	480	450	430	570	720	920	1,150	1,210	1,130	1,290	1,590
Other finance	2,230	2,060	1,350	1,140	930	1,440	1,850	1,700	1,620	1,820	2,050
Non-corporate:											
Security brokers	1,820	1,010	370	100	200	260	200	300	280	240	260
Foreign banks	700	790	500	260	140	170	480	540	640	710	1,160
Other foreigners‡	960	850	520	450	250	310	580	790	800	1,070	1,710
Public bodies—total	*2,450*	*2,490*	*2,450*	*2,170*	*2,860*	*4,390*	*4,580*	*4,560*	*4,270*	*5,410*	*4,950*
United States Treasury	190	330	520	520	1,020	1,840	1,450	1,240	970	1,820	1,480
Other public bodies	2,270	2,160	1,930	1,650	1,840	2,550	3,120	3,320	3,290	3,580	3,470
Unclassified—balances of individuals, non-profit organizations, banks' trust departments, etc.	*36,600*	*36,510*	*35,140*	*32,970*	*30,110*	*32,800*	*36,040*	*39,630*	*40,190*	*40,460*	*43,470*

* Demand deposits are adjusted for items in process of collection by banks and exclude domestic interbank deposits.
† Excludes professional service, agriculture, finance, transportation, and public utilities.
‡ Includes foreign bank deposits with non-member banks.
Note: Figures are rounded and will not necessarily add up to totals.

TABLE III

THE DISTRIBUTION OF DEMAND DEPOSITS BY TYPE OF HOLDER

(millions of dollars—end of year figures)

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
*Total**	*23,720*	*21,950*	*18,600*	*16,560*	*16,180*	*20,610*	*24,120*	*27,310*	*25,650*	*28,550*	*32,420*
Business—total	*8,340*	*8,120*	*6,690*	*6,640*	*6,130*	*6,870*	*7,450*	*8,430*	*7,680*	*8,630*	*9,480*
Corporations engaged in:											
Manufacturing, mining, and construction	3,680	3,700	3,160	3,020	2,800	2,940	3,430	3,690	3,450	4,080	4,660
Transportation and public utilities	1,220	1,260	980	990	980	1,030	1,050	1,340	1,000	1,220	1,340
Trade, service, agriculture, and miscellaneous	1,620	1,450	1,180	1,190	1,120	1,430	1,460	1,680	1,590	1,610	1,660
Non-corporate enterprises:†	1,830	1,710	1,370	1,340	1,220	1,480	1,520	1,720	1,650	1,720	1,810
Finance—total	*5,470*	*4,330*	*2,860*	*2,270*	*1,960*	*2,740*	*3,850*	*4,120*	*4,060*	*4,670*	*6,220*
Corporations engaged in:											
Insurance	380	350	340	440	560	720	900	950	890	1,010	1,250
Other finance	1,970	1,830	1,190	1,010	820	1,300	1,700	1,560	1,490	1,670	1,880
Non-corporate:											
Security brokers	1,820	1,010	370	100	200	260	200	300	280	240	260
Foreign banks	550	550	480	260	130	170	470	530	630	700	1,150
Other foreigners‡	750	590	490	450	240	290	570	780	780	1,050	1,680
Public bodies—total	*1,890*	*1,970*	*2,060*	*1,810*	*2,550*	*4,080*	*4,170*	*4,170*	*3,620*	*4,820*	*4,420*
United States Treasury	190	330	520	520	1,020	1,840	1,450	1,240	970	1,820	1,480
Other public bodies	1,700	1,640	1,530	1,290	1,530	2,240	2,710	2,930	2,650	3,000	2,930
Unclassified—balances of individuals, non-profit organizations, banks' trust departments, etc.	*8,020*	*7,530*	*6,900*	*5,940*	*5,540*	*6,820*	*8,660*	*10,590*	*10,280*	*10,410*	*12,310*

* Demand deposits are adjusted for items in process of collection by banks and exclude domestic interbank deposits.

† Excludes professional service, agriculture, finance, transportation, and public utilities.

‡ Includes foreign bank deposits with non-member banks.

Note: Figures are rounded and will not necessarily add up to totals.

TABLE IV

THE DISTRIBUTION OF TIME DEPOSITS BY TYPE OF HOLDER

(millions of dollars—end of year figures)

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Total	*28,120*	*28,610*	*25,990*	*24,440*	*21,790*	*23,190*	*24,230*	*25,400*	*26,260*	*26,380*	*27,060*
Business—total	*1,450*	*1,430*	*1,180*	*1,160*	*1,080*	*840*	*590*	*680*	*600*	*680*	*750*
Corporations engaged in:											
Manufacturing, mining, and construction	760	760	650	620	580	420	290	310	290	340	390
Transportation, and public utilities	340	350	270	280	270	200	130	160	120	140	150
Trade, service, agriculture, and miscellaneous	130	110	100	90	90	100	90	100	90	90	100
Non-corporate enterprises:*	230	200	160	160	140	130	90	110	100	110	110
Finance—total	*630*	*740*	*240*	*190*	*220*	*280*	*300*	*310*	*300*	*340*	*410*
Corporations engaged in:											
Insurance	90	80	80	100	130	170	210	220	200	230	290
Other finance	180	160	110	90	70	90	80	70	70	80	90
Non-corporate:											
Security brokers	—	—	—	—	—	—	—	—	—	—	—
Foreign banks	150	240	30	—	10	10	10	10	10	10	10
Other foreigners†	210	260	30	—	10	10	10	10	20	20	20
Public bodies—total	*570*	*520*	*390*	*360*	*310*	*310*	*410*	*390*	*640*	*580*	*550*
United States Treasury	—	—	—	—	—	—	—	—	—	—	—
Other public bodies	570	520	390	360	310	310	410	390	640	580	530
Unclassified—balances of individuals, non-profit organizations, banks' trust departments, etc.	*25,540*	*25,920*	*24,180*	*22,740*	*20,170*	*21,770*	*22,930*	*24,030*	*24,710*	*24,780*	*25,370*

* Excludes professional service, agriculture, finance, transportation, and public utilities.

† Includes foreign bank deposits with non-member banks.

Note: Figures are rounded and will not necessarily add up to totals.

the thirties reflect the trends of business activity, sharply downward from 1929 until 1933 and upward thereafter. Generally speaking, all the groups and subgroups of holders follow the movements indicated by the aggregate, although the rise in the holdings of insurance companies appears to lead the upward movement.

At the end of 1939 the business group held over a billion dollars more than at the beginning of the decade. Nevertheless, the proportion of the total money supply held by business declined throughout the period, from roughly one-third of the aggregate in 1929 to about one-fourth in 1939. The relative importance of the financial group likewise declined, from approximately one-fifth to one-sixth of the total. This relative decrease occurred in spite of substantial additions to the holdings of insurance companies and foreigners toward the end of the thirties. Public bodies began to add to their money holdings after 1932, largely due to a rather steady growth of state and local government funds. United States Treasury holdings fluctuated considerably but at a higher level after the early years. Some of the importance lost by the business and finance groups was gained by public bodies in the shifts occurring over the period. The unclassified group of holders increased their money both in absolute and in relative terms during the decade. This group being residual in its derivation is composed not only of consumers and non-profit organizations, but also of elements which are really financial in nature, such as banks' trust departments and very large accounts of individuals. The explanation of the changes which occurred in this last category will therefore be even more complex than the causes of shifts affecting the other groups.

VARIATIONS IN EXPENDITURES WHERE FAMILIES OF WAGE EARNERS AND CLERICAL WORKERS ARE CLASSIFIED BY ECONOMIC LEVEL

By Roy C. Cave

Since the appearance of the book by Allen and Bowley on *Family Expenditures*,[1] most such studies have dealt with expenditures of families classified according to net family income or total family expenditure, not according to total expenditure per expenditure unit.[2] In the present study, analyses are made of variations of expenditures at 12 economic levels (1) on selected main categories of items by 446 San Francisco-Oakland families sorted by economic level; and (2) per person on selected individual clothing items by 14,469 families, sorted by economic level. The basic data used are taken from the nationwide survey, "Money Disbursements of Wage Earners and Clerical Workers, 1934–36," made by the Bureau of Labor Statistics of the United States Department of Labor.

A. D. H. Kaplan has already shown that, in Chicago, for most general categories or groups of commodities, use of linear regressions is feasible where families are classified by income and occupation, up to the $5,000 level.[3] One purpose of the present study is to indicate the feasibility of the use of linear regressions where families with net incomes below $4,000, and belonging to related occupational groups, are classified by economic level. The first of the two analyses made illustrates the use of the least squares method where family expenditures on groups of items are plotted against total family expenditures. The second illustrates the same method where expenditures by individuals on specific items are plotted against expenditures on the sub-group to which those specific items belong.[4]

[1] Allen, R. D. G., and Bowley, A. L., *Family Expenditures, A Study of Its Variation*, 1935.

[2] When families are classified by income level, no account is taken of the effect of differences in family size and composition on the plane of living. To meet this difficulty, families may be classified by economic level, as measured by the amount spent per total expenditure unit. The Bureau of Labor Statistics calculates the total expenditure unit for any given family by combining the amounts spent by the family per food expenditure unit and per clothing expenditure unit, and adding to this sum the amount the family spends per adult male equivalent for "other items." The food expenditure unit is the average expenditure for food of full-time employed men, aged 20 and over. The clothing expenditure unit is the average annual clothing expenditure of white men wage earners and clerical workers aged 21 to 35 inclusive, in all cities covered by the 1934–36 expenditure study of the Bureau. *Cf.* U. S. Bureau of Labor Statistics, Bulletin No. 639, 1939, pp. 344–351.

[3] Kaplan, A. D. H., "Expenditure Patterns of Urban Families," this Journal, Vol. 33, No. 201, March, 1938, pp. 88–100.

[4] By means of the method of least squares it is possible to express broad consumption tendencies, such as Engel's law of food consumption. The constant b indicates the slope of the regression line, and at the same time the dollar (or fraction thereof) increases in expenditure on a given item for every dollar increase in spendable funds.

Another purpose is to provide additional bases for estimating family and individual expenditures at different economic levels, for classifying groups of items and individual items according to urgency of wants for them, and for estimating elasticity of demand.[5] Various coefficients and other measures have been computed to indicate accuracy of estimates, degree of correlation, and expenditure elasticity.

At low and modest income levels, total expenditure provides a more suitable basis for many purposes than net family income for classifying families in terms of *effective* incomes, since total expenditure tends to exceed net income. And when families are classified in terms of total expenditure per expenditure unit, the influence of increasing effective income on group or individual expenditures can be measured still more precisely. This is especially true if the study is confined to a given occupational group, or closely related groups. Expenditure data analyzed here are taken from two groups (families of wage earners and clerical workers) having about the same income range and similar habits of expenditure. Where wage earner groups are analyzed separately from business and professional groups, many types of expenditure tend to become more linear, since at higher income levels expenditures increase more slowly, and thus at upper levels expenditure curves covering a wide range of income will turn downward.

Expenditures of the 446 San Francisco-Oakland wage earner and clerical families, when classified by income rather than economic level, were estimated by Williams and Hanson[6] from the regression equation $Y=a+bX^{1/2}+cX$, where X is annual net income. This equation was selected after experimentation had established that most categories of expenditure were curvilinear.[7] It was found to give about as good a fit for those categories which were linear. Values of a, b, and c are not given with estimated expenditures.

When classified by economic level, as might be expected, these same families have average expenditures which tend to be more linear. Food, housing, and fuel, light, and refrigeration, all of which were found by Williams and Hanson to be curvilinear when the data are sorted by

[5] If the group of families analyzed is a representative sample of the universe to which it belongs, and if further no material change has occurred in retail prices during the period of the study, it may be assumed that an increase of funds available for expenditure is roughly equivalent to a decrease of price with spendable funds remaining unchanged. Hence, measures of expenditure elasticity are also approximations to demand elasticity.

[6] Williams, F. M., and Hanson, A. C., "Money Disbursements of Wage Earners and Clerical Workers in Five Cities of the Pacific Region, 1934–36." U. S. Bureau of Labor Statistics Bulletin 639, 1939, pp. 284, 304–305.

[7] Only personal care, medical care, household operation other than fuel, light, and refrigeration, gifts, and miscellaneous items were truly linear. Weighting by the number of cases, total expenditure, etc., did not yield better results than use of the average actual expenditure for each income group.

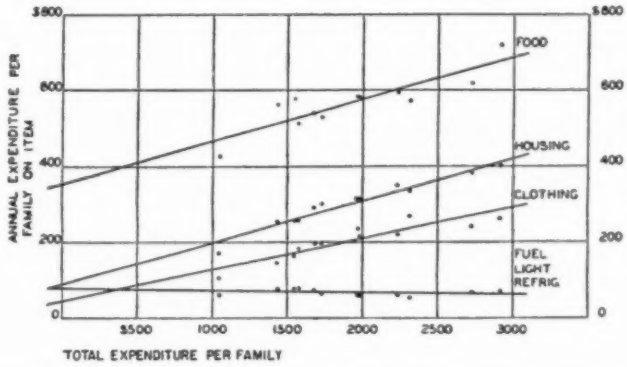
income, are definitely linear, while clothing outlays are only slightly curvilinear. Regressions for only these four main categories are shown in the present analysis. However, additional estimates have been made for other household operation; furnishings and equipment; automobiles, motorcycles and other transportation; and all other items. Only the category, automobiles, motorcycles and other transportation tends to be curvilinear.[8]

In Chart I, annual expenditures per family (Y) for four groups of items are plotted against total expenditure per family (X) for twelve economic levels, and a line of least squares is fitted to each series of data.

CHART I

SAN FRANCISCO-OAKLAND WHITE, NON-RELIEF WORKERS* FAMILIES, 1934–36

Expenditures of 446 Families, Classified by Economic Level† for Food, Housing, Clothing, and Fuel, Light, and Refrigeration



* Derived from U. S. Bureau of Labor Statistics, Bulletin 639, "Money Disbursements of Wage Earners and Clerical Workers in Five Cities in the Pacific Region, 1934–36," 1939, p. 132.

† That is, families are classified according to their total expenditures per total expenditure unit, not according to total income per family without regard to family size and composition.

At the zero point of origin a is positive in the four cases, indicating that all are "necessities." In order of urgency, that complex of wants known as food ranks first, followed in turn by the complexes known as housing, fuel, light and refrigeration, and clothing. While this ranks food as the prime necessity, two qualifications seem required. First, food is not simply a necessity, but a complex of wants, some of which are comforts and luxuries. The same is true of clothing, housing, and

[8] The following equations were obtained:

other household operation—$Y = 1.00 + .05033X$
furnishings and equipment—$Y = -57.17 + .0692X$
all other items—$Y = -127.1 + .2515X$

other groups of items. The second qualification is that extending the fitted line beyond the plotted data is a questionable procedure.

Note that b is slightly negative in the case of fuel, light, and refrigeration. This negative tendency is partly due to the fact that nearly one-half of the 446 families lived in apartments, and that some of these latter made no separate payment for heat. A larger proportion of families in high than those at low income levels lived in apartments, and these families were especially concentrated at high income levels. Families living in apartments spend less on the average for fuel, light and refrigeration even when they pay for heat. Families at higher levels, too, tend to be smaller in size, so that fuel, light and refrigeration requirements are lower. Among families making no such separate payment, those at the highest levels apparently did less cooking at home.[9] Only the data for clothing show any definite signs of being curvilinear.

Table I gives essential estimates and measures for the four groups of items. The standard error of estimate (S_y) and the coefficient of correlation (r_{yx}) are adjusted for the number of cases (i.e., the number of averages). The coefficient, and adjusted coefficient of correlation are negative in the case of fuel, light, and refrigeration. They are also so low as to indicate very little relationship, for this group of items, between total expenditure and group expenditure. Evidently, too, clothing outlays, while affected by rising economic level, are substantially influenced as well by other considerations. The adjusted coefficient of determination ($\bar{d}_{yx}$) is only .479. Note the high correlation and coefficient of determination in the case of housing expenditures. The standard error[10] of b_{yx} is relatively higher in the cases of clothing, and fuel, light, and refrigeration. In the case of the latter, it is almost as large as b, but b is exceedingly small. The expenditure elasticity (η) is considerably less than unity in all cases.[11] It is negative and extremely low for fuel, light, and refrigeration, very low for food, and highest for clothing. Elasticities for food, clothing, and fuel, light, and refrigeration decline, and housing elasticity increases, when families are grouped by economic level, judging by comparisons made with Kaplan's Chicago study in which families are grouped by income. Stated differently, when families are arranged according to effective income, i.e., funds available for ex-

[9] Williams and Hanson, *op. cit.*, pp. 211–212. The outlay for gas tended to decline.

[10] Cf. Ezekiel, Mordecai, *Methods of Correlation Analysis*, 2nd ed., 1941, pp. 312–14. The formula for σ_b is $\frac{\bar{S}_y}{\sigma_x \sqrt{n}}$.

[11] Computed by the formula, $\eta = k/\bar{w}$, where η = expenditure elasticity, k = the constant b, and $\bar{w}$ = the percentage of total expenditures devoted by all families to the group of items; or $\eta = b/p$ since $b = \Delta e/\Delta i$ and $e/i = p$, where Δe is increase of expenditure, Δi is increase of total expenditure, and p is percentage of total expenditure.

TABLE I

LINEAR REGRESSION CONSTANTS, ELASTICITY OF EXPENDITURE, AND MEASURES OF ACCURACY OF ESTIMATE AND DEGREE OF CORRELATION

Expenditures of 446 San Francisco-Oakland White Non-Relief Families of Wage Earners and Clerical Workers, Classified by Economic Level, 1934–36

Economic level	Total expenditure per family	Food		Housing		Clothing		Fuel, light, refrigeration	
	X	Y	Y_c	Y	Y_c	Y	Y_c	Y	Y_c
Under $ 300	$1,039	$ 425	$470	$ 171	$ 203	$ 104	$ 130	$ 61	$ 70.22
$ 300– 400	1,429	562	513	251	247	146	162	74	68.66
400– 500	1,541	579	526	255	260	163	171	74	68.22
500– 600	1,570	515	529	256	263	183	174	78	68.10
600– 700	1,686	542	542	290	276	198	183	69	67.64
700– 800	1,723	532	546	304	280	195	186	67	67.49
800– 900	1,977	582	574.6	314	309	239	206.9	64	66.47
900–1,000	1,984	579	575.4	316	310	210	207.4	64	66.44
1,000–1,100	2,232	596	603	353	338	222	228	63	65.45
1,100–1,200	2,311	573	612	339	346	267	234	54	65.14
1,200–1,300	2,722	619	658	388	393	241	268	64	63.49
1,300 and over	2,914	725	680	402	414	266	284	68	62.72
Total	$23,128	$6,829	$6,829	$3,639	$3,639	$2,434	$2,434.3	$800	$801.04
Mean	$ 1,927.3	$ 569.08		$ 303.25		$ 202.8		$ 66.67	
Measures and adjustments									
a_{yx}		$+353.22		$+86.62		$+44.80		$+74.38	
b_{yx}		$+ .112		$+ .1124		$+ .082		$− .004	
σ_b		$ .0198		$ .0086		$ .0119		$ .0035	
S_y		$ 32.6		$ 14.1		$ 19.6		$ 5.9	
$\bar{S}_y$		$ 35.7		$ 15.5		$ 21.4		$ 6.4	
r_{yx}		+ .875		+ .95		+ .73		− .34	
$\bar{r}_{yx}$		+ .861		+ .945		+ .697		− .16	
d_{yx}		.766		.903		.53		.116	
$\bar{d}_{yx}$		.742		.893		.486		.027	
η		.338		.677		.745		− .095	
σ_x		$ 521.00							

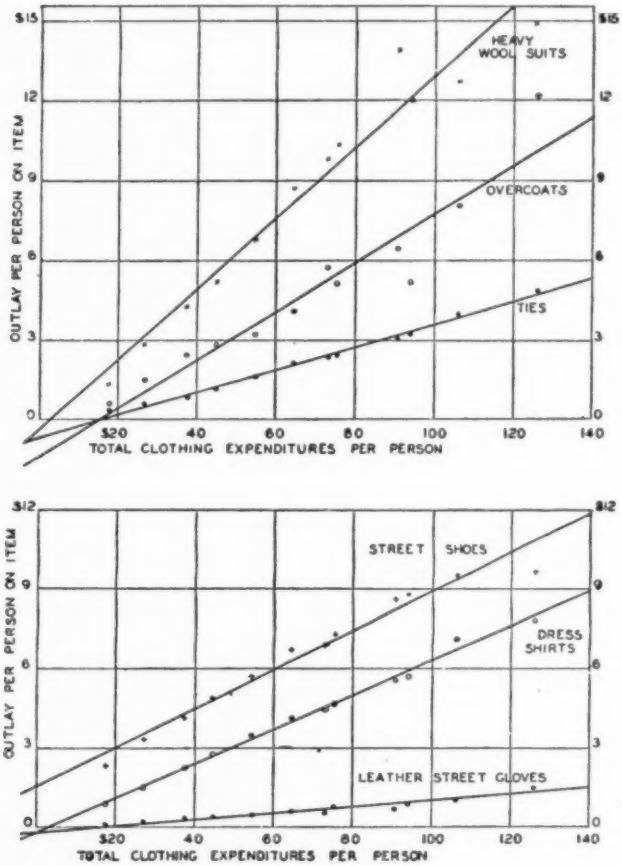
penditure per expenditure unit, distinctly different elasticities are obtained.

Chart II shows plotted data and fitted lines for six selected individual clothing items. In this case, Y represents expenditure on the individual item and X total clothing outlay per person for men, and boys 18 years of age and over.[12] Since the intercept a is negative for all items except street shoes, it would appear that street shoes alone should be regarded as a necessity. However, this is extension of the fitted line beyond the

[12] X may be regarded as total expenditure for a sub-group, by economic level, since expenditures of men and boys 18 and over constitute a family sub-group.

CHART II

CLOTHING EXPENDITURES* BY ECONOMIC LEVEL† AND PER PERSON, MEN AND BOYS 18 AND OVER,‡ IN 14,469 FAMILIES OF NON-RELIEF WHITE AND NEGRO WAGE EARNERS AND CLERICAL WORKERS, 1934-36, 42 CITIES OF UNITED STATES



* Derived from U. S. Bureau of Labor Statistics, Bulletin No. 639, "Money Disbursements of Wage Earners and Clerical Workers, 1934-36," Summary Volume, pp. 60, 274.

† Families are classified according to total expenditure per expenditure unit.

‡ Expenditure per person, with only persons dependent on family funds for 52 weeks included.

data. In point of fact, as total expenditures approach zero, there is a noticeable tendency for practically all plotted expenditures to turn downward. Expenditures for most items become more elastic at very low income or economic levels. At any rate, judging from the height

TABLE II

LINEAR REGRESSION CONSTANTS, ELASTICITY OF EXPENDITURE, AND MEASURES OF ACCURACY OF ESTIMATE AND DEGREE OF CORRELATION

Clothing expenditures by economic level of men, and boys 18 and over, in 14,469 white and Negro families of wage earners and clerical workers in 42 cities of the United States
(Non-Relief Families, Expenditures For One Year During 1934–36)

Economic level	Total clothing expenditure per person	Heavy wool suits		Overcoats		Ties		Street shoes		Dress shirts		Leather street gloves	
	X	Y	Y_c	Y	Y_c	Y	Y_c	Y	Y_c	Y	Y_c	Y	Y_c
Under $ 300	$ 17.42	$ 1.34	$ 1.93	$ .60	$ .22	$ .26	$ .13	$2.34	$2.84	$ .90	$ .97	$.04	$ .00
$ 300– 400	26.89	2.84	3.19	1.51	1.09	.57	.53	3.33	3.53	1.53	1.58	.16	.11
400– 500	37.32	4.31	4.58	2.45	2.04	.93	.97	4.16	4.28	2.28	2.25	.24	.23
500– 600	44.65	5.17	5.56	2.76	2.71	1.26	1.28	4.85	4.82	2.79	2.73	.33	.32
600– 700	54.47	6.80	6.86	3.27	3.61	1.69	1.70	5.70	5.53	3.44	3.36	.44	.44
700– 800	64.06	8.77	8.14	4.19	4.49	2.13	2.11	6.70	6.23	4.14	3.98	.55	.55
800– 900	73.07	9.85	9.34	5.81	5.31	2.43	2.49	6.87	6.88	4.46	4.57	.54	.65
900–1,000	75.87	10.43	9.71	5.17	5.57	2.53	2.61	7.24	7.08	4.73	4.75	.76	.69
1,000–1,100	90.88	13.99	11.71	6.45	6.94	3.09	3.25	8.62	8.17	5.56	5.72	.66	.86
1,100–1,200	93.86	12.04	12.11	5.18	7.21	3.30	3.37	8.82	8.39	5.72	5.91	.88	.90
1,200–1,300	106.14	12.75	13.75	8.11	8.34	3.97	3.90	9.49	9.28	7.15	6.71	1.00	1.04
1,300 and over	125.73	14.95	16.36	12.16	10.13	4.90	4.73	9.62	10.70	7.82	7.97	1.47	1.27
Total	$810.36	$103.24	$103.24	$57.66	$57.66	$27.06	$27.07	$77.74	$77.73	$50.52	$50.50	$7.07	$7.06
Mean	$ 67.53	$ 8.603		$ 4.805		$ 2.255		$ 6.478		$ 4.21		$ .589	
Measures and adjustments													
a_{yx}		$−.392		$−1.369		$−.615		$+1.575		$−.16		$−.204	
b_{yx}		$+.1332		$ +.09143		$+.0425		$ +.0726		$+.0647		$+.01175	
σ_b		$ .009		$ .0089		$ .000885		$ .00423		$ .001658		$ .00092	
S_y		$ .916		$ .896		$ .089		$ .426		$ .167		$ .093	
$\bar{S}_y$		$ 1.003		$ .982		$ .098		$ .467		$ .183		$ .102	
σ_x		$31.827		$ 31.827		$31.827		$ 31.827		$31.827		$31.827	
r_{yx}		+.976		+.955		+.999		+.944		+.996		+.97	
$r_{\bar{y}x}$		+.947		+.95		+.997		+.938		+.991		+.93	
d_{xy}		.95		.912		.998		.89		.992		.94	
$\bar{d}_{xy}$		.896		.902		.994		.88		.982		.865	
η		1.07		1.40		1.43		.69		1.04		1.53	

of a, in order of urgency street shoes rank first, followed by dress shirts, leather gloves, suits, ties and overcoats. It may be that the last five can be made to last longer if income is insufficient, and that gloves and ties, at least, can be eliminated entirely.

Table II gives estimated regressions of Y on X, and summarizes important measures bearing on accuracy of estimate and degree of correlation. For these data b represents the dollar change (or fraction thereof) in expenditure on the item for every dollar increase in average total clothing expenditure by men, and boys 18 years and over. This coefficient, b_{yz}, is largest for heavy wool suits and overcoats, followed next by street shoes and dress shirts. For leather gloves, b is extremely small.

S_y is larger relative to size of estimated expenditures (Y_c) in the case of these expenditures on individual items than in the previous case where expenditures are for groups of items. This illustrates the value of accompanying measures of accuracy. The five "luxury" items all necessarily have an expenditure elasticity greater than unity (since the intercept a is negative in each case), while the ratio for street shoes is only .69. Variation in the expenditure elasticity of even these few individual clothing items demonstrates the inaccuracy of speaking of clothing in general as a "necessity," or a "luxury," depending on the method of income classification.[13]

[13] For families grouped by net family income, the general category clothing tends to be a "luxury," since η is greater than 1. For families classified by economic level, it is a "necessity" since η is definitely less than 1.

FITTING POLYNOMIAL TRENDS TO SEASONAL DATA BY THE METHOD OF LEAST SQUARES

By Howard L. Jones

THE PROBLEM discussed in this article is that of fitting a polynomial trend to an equally spaced time series with unknown seasonal differences in such manner that the seasonal differences and the coefficients of the polynomial are computed simultaneously so as to minimize the sum of the squared residuals. This problem is simple in theory; but its solution appears to have been overlooked in the literature on fitting trends.[1] Sasuly[2] suggests that fitting certain arcs by an iterative procedure will tend to eliminate the seasonal element; but there is no reason to suppose that this procedure will approximate the least squares solution. Macaulay[3] argues that the method of least squares is not suitable for computing trend midordinates for a seasonal series, and chooses flexibility and smoothness as principal criteria for judging graduation

TABLE I

WEIGHTS TO BE APPLIED TO TWELVE-MONTH MOVING TOTALS TO FIND THE MIDORDINATE OF A FITTED THIRD-DEGREE PARABOLA

No. of terms, original series	15	17	19	21	23
No. of moving totals	4	6	8	10	12
Multiply sum of first and last totals by	−73	−158	−267	−412	−55
Multiply sum of all intermediate totals by	85	109	145	193	23
Add products and divide by	288	1440	4032	8640	1440
Standard error ratio	.649	.425	.363	.335	.318

formulas devised by himself and other writers. His argument seems to rest chiefly on the fact that a moving arc fitted to a monthly series by a method that ignores the seasonal differences is obviously a biased estimate of the trend. In fitting moving arcs by the procedure outlined in Table I, the seasonal differences are taken into account.

Let Y_x be the general expression for one of a series of n terms with

[1] In the *Journal of Accountancy* for September, 1937 (Vol. 64, pp. 174–199), Arne Fisher discusses the problem of fitting a fifth-degree polynomial, in the orthogonal form, to 25 terms in a monthly series. His solution, however, is defective in at least two respects: (1) To find the first coefficient of his polynomial, he takes the arithmetic mean of the 25 terms; but this will yield a biased estimate because one of the seasonal differences is contained three times in the series while each of the other seasonal differences is contained but twice. (2) Taking the arithmetic mean to find the first coefficient implies that the observational errors are independent; but the other coefficients are obtained by fitting the 13 differences obtained by subtracting each observation from the observation twelve months later, which implies that the errors in the 13 differences are independent. Both implications can not be correct.

[2] Sasuly, M., *Trend Analysis of Statistics*, 1934, p. 181.

[3] Macaulay, F. R., *The Smoothing of Time Series*, 1931, pp. 46–50.

subscripts at unit intervals of x ranging from $-l$ to $+l$ where $l=\frac{1}{2}(n-1)$. We are to fit the function

$$f_x = y_x + k_i$$

to this series, where

$$y_x = a_0 + a_1x + a_2x^2 + \cdots + a_rx^r$$

and k_i is one of p seasonal differences, repeating itself every pth term, so that

$$k_x = k_{x\pm p}.$$

Assume $n \geqq r+p$. The problem is to find the values of $a_0, a_1, a_2, \cdots, a_r$ and $k_1, k_2, k_3, \cdots, k_p$ which, taken simultaneously, minimize the function

$$z = \sum_{x=-l}^{l} (f_x - Y_x)^2,$$

with the condition imposed that $\sum_{i=1}^{p} k_i = 0$.

To develop certain general relationships, let us write

$$y_x = a_0 + u_x,$$

and

$$z = \sum_{x=-l}^{l} (a_0 + u_x + k_i - Y_x)^2 + \lambda \sum_{i=1}^{p} k_i \qquad (1)$$

where λ is a Lagrange multiplier.[4] Then our solution must satisfy the equations obtained by setting the partial derivatives of z with respect to a_0 and each of the k's equal to zero. Setting the partial derivative of z with respect to some particular k_i equal to zero yields the equation

$$2m_i(a_0 + u_i + k_i - Y_i) + \lambda = 0 \qquad (2)$$

where m_i is the number of times k_i occurs in the series $\sum_{x=-l}^{l} k_x$, and u_i and Y_i are the means of the values of u_x and Y_x, respectively, for those months or seasons in which k_i occurs. Summing equations like (2) for all the different k_i's yields

$$2\sum_{i=1}^{p} (m_ia_0 + m_iu_i + m_ik_i - m_iY_i) + p\lambda = 0.$$

This is equivalent to

$$2\sum_{x=-l}^{l} (a_0 + u_x + k_i - Y_x) + p\lambda = 0.$$

[4] See Osgood, W. F., *Advanced Calculus*, 1933, p. 180.

But setting $\partial z/\partial a_0$ equal to zero yields

$$2 \sum_{x=-l}^{l} (a_0 + u_x + k_i - Y_x) = 0.$$

It follows that $\lambda = 0$. Hence, the terms in λ may be omitted from (1) and its derivatives, and the solution we seek may be obtained by partial differentiation[5] of

$$z = \sum_{x=-l}^{l} (a_0 + u_x + k_i - Y_x)^2.$$

By substituting zero for λ in (2) we find that

$$a_0 + u_i + k_i - Y_i = 0$$

or

$$k_i = Y_i - y_i \tag{3}$$

where y_i is defined as $a_0 + u_i$; that is, y_i is the mean of the values of y_x for the months or seasons in which k_i occurs. This means that when the trend polynomial has been computed, the least squares solution for each seasonal difference can be obtained by finding the mean difference between the observed values and the computed trend for the months or seasons in which that particular seasonal difference occurs. By summing equations like (3) we find

$$\sum_{i=1}^{p} k_i = \sum_{i=1}^{p} Y_i - \sum_{i=1}^{p} y_i.$$

Since $\sum_{i=1}^{p} k_i$ is specified to be zero, this becomes

$$\sum_{i=1}^{p} y_i = \sum_{i=1}^{p} Y_i,$$

which is equivalent to

$$\sum_{x=-l}^{l} \frac{y_x}{m_x} = \sum_{x=-l}^{l} \frac{Y_x}{m_x}$$

where m_x is defined as the number of times the month or season corresponding to x occurs in the entire series of terms. Since

$$\sum_{x=-l}^{l} \frac{1}{m_x} = p$$

[5] The equation $\sum_{i=1}^{p} k_i = 0$ must be used in the solution, however, since the equations obtained from the partial derivatives are not independent.

in all cases, the least squares trend when r (the degree of the polynomial) is zero, is

$$a_0 = \frac{1}{p} \sum_{x=-l}^{l} \frac{Y_x}{m_x} \cdot \tag{4}$$

To illustrate, take the simple problem of fitting a horizontal trend to a series covering 15 consecutive months beginning with May of one year and ending with July of the following year. In this case, $m_x = 2$ for May, June, and July of each year, since each of these three months occurs twice in the series. For each of the remaining nine months $m_x = 1$. Since $p = 12$, we have by substitution in (4),

$$a_0 = \frac{1}{12}\left\{ \sum_{-7}^{-5} Y_x/2 + \sum_{-4}^{4} Y_x + \sum_{5}^{7} Y_x/2 \right\}$$

or

$$a_0 = \frac{1}{24} \sum_{-7}^{-5} Y_x + \frac{1}{12} \sum_{-4}^{4} Y_x + \frac{1}{24} \sum_{5}^{7} Y_x.$$

To find the line of least squares for the same series, put

$$z = \frac{1}{2} \sum_{x=-l}^{l} (a_0 + a_1 x + k_i - Y_x)^2.$$

Setting the partial derivatives with respect to a_0, a_1, and each k_i equal to zero yields

$$15a_0 + k_1 + k_2 + k_3 + k_4 + 2k_5 + 2k_6 + 2k_7 + k_8 + k_9 + k_{10} + k_{11} + k_{12} = \sum_{-7}^{7} Y_x$$

$$280a_1 + k_1 + 2k_2 + 3k_3 + 4k_4 - 2k_5 + 2k_7 - 4k_8 - 3k_9 - 2k_{10} - k_{11} = \sum_{-7}^{7} xY_x$$

$$a_0 - 4a_1 + k_8 = Y_{-4}$$

$$a_0 - 3a_1 + k_9 = Y_{-3}$$

. . . . . .

$$a_0 + 4a_1 + k_4 = Y_4$$

$$2a_0 - 2a_1 + 2k_5 = Y_{-7} + Y_5$$

$$2a_0 + 2k_6 = Y_{-6} + Y_6$$

$$2a_0 + 2a_1 + 2k_7 = Y_{-5} + Y_7$$

By subtracting $\sum_{i=1}^{12} k_i = 0$ plus one-half the sum of the last three equations from the first equation in this set, we obtain

$$12a_0 = \frac{1}{2} \sum_{-7}^{-5} Y_x + \sum_{-4}^{4} Y_x + \frac{1}{2} \sum_{5}^{7} Y_x.$$

Subtracting appropriate multiples of the last twelve equations from the second equation in the set so as to eliminate all the k's gives us

$$216a_1 = 6\sum_{5}^{7} Y_x - 6\sum_{-7}^{-5} Y_x.$$

It follows that

$$a_0 = \frac{1}{24}\sum_{-7}^{-5} Y_x + \frac{1}{12}\sum_{-4}^{4} Y_x + \frac{1}{24}\sum_{5}^{7} Y_x \tag{5}$$

and

$$a_1 = \frac{1}{36}\sum_{5}^{7} Y_x - \frac{1}{36}\sum_{-7}^{-5} Y_x. \tag{6}$$

Coefficients of polynomials of higher degree may be computed in a similar manner; but the procedure will frequently require considerable time and involve large numbers that are cumbersome to handle. On the other hand, when a general solution for the coefficients has once been obtained for some combination of r, p and n, and written down in a convenient place for future reference, the computation of a particular regression coefficient resolves itself into the simple procedure of applying a set of weights to the observed series.

Before deriving weights for fitting parabolas to seasonal data, let us consider briefly one or two devices that have been invented as aids in solving the problem of fitting polynomials to data that do not contain seasonal differences.[6] A very important contribution was the invention of the orthogonal polynomials. The first four of these polynomials may be written

$$G_{(0,x)} = 1,$$
$$G_{(1,x)} = x,$$
$$G_{(2,x)} = x^2 - \frac{n^2 - 1}{12},$$

and

$$G_{(3,x)} = x^3 - \frac{3n^2 - 7}{20}x.$$

In terms of these polynomials, the least squares regression curve may be written

[6] For a list of references to this problem, see Yule, G. U., and Kendall, M. G., *An Introduction to the Theory of Statistics*, 1937, references for Ch. 17, pp. 514–515.

$$A_0G_{(0,x)} + A_1G_{(1,x)} + A_2G_{(2,x)} + \cdots + A_rG_{(r,x)};$$

that is,

$$y_x = \sum_{i=0}^{r} A_iG_{(i,x)}. \tag{7}$$

These polynomials have the property that

$$\sum_{x=-l}^{l} G_{(i,x)}G_{(j,x)} = 0$$

for all combinations of i and j except those where $i=j$. It follows that the least squares solution for the regression coefficient is

$$A_i = \frac{\sum_{-l}^{l} G_{(i,x)}Y_x}{\sum_{-l}^{l} G^2_{(i,x)}},$$

or

$$A_i = \sum_{-l}^{l} v_xY_x$$

where

$$v_x = \frac{G_{(i,x)}}{\sum_{-l}^{l} G^2_{(i,x)}}.$$

Tables are now available[7] for the convenient computation of the coefficients.

By substituting equivalent values, (7) may be written in the form

$$y_x = \sum_{i=0}^{r}\left\{\sum_{x=-l}^{l} \frac{G_{(i,x)}Y_x}{\sum_{x=-l}^{l} G^2_{(i,x)}}\right\}G_{(i,x)}.$$

At the ordinate where $x=t$, this becomes

$$y_t = \sum_{i=0}^{r}\left\{\sum_{x=-l}^{l} \frac{G_{(i,x)}Y_x}{\sum_{x=-l}^{l} G^2_{(i,x)}}\right\}G_{(i,t)}.$$

[7] See Davis, H. T., *Tables of the Higher Mathematical Functions*, Vol. II, 1935, pp. 307–359; or Fisher, R. A., and Yates, F., *Statistical Tables for Biological, Agricultural and Medical Research*, 1938, table XXIII.

Collecting terms in each Y_x yields

$$y_t = \sum_{x=-l}^{l} w_{(r,x)} Y_x$$

where

$$w_{(r,x)} = \sum_{i=0}^{r} \frac{G_{(i,x)} G_{(i,t)}}{\sum_{x=-l}^{l} G^2_{(i,x)}} . \tag{8}$$

This formula is useful in deriving a set of weights which can be applied to the observed series of Y's to find the regression curve at any ordinate $x=t$. Sheppard's weights,[8] which are useful in fitting moving arcs to a nonseasonal series, can be obtained by setting $t=0$. Weights for computing the definite integral $\int_{t_1}^{t_2} y_x dx$ may be found by substituting $\int_{t_1}^{t_2} G_{(i,x)} dx$ for $G_{(i,t)}$ in (8).

Now weights identical with those obtained from (8) can also be derived directly by a procedure resting on the principle that, under certain conditions, the least squares solution is the unbiased linear estimate with minimum mean square error. Let ψ_t be a trend ordinate which it is desired to estimate. Assume that each observational error, $\epsilon_x = Y_x - \psi_x$, is a real number selected at random from a normal universe with mean zero and variance σ_ϵ^2. Let $y_t = \sum_{-l}^{l} w_x Y_x$ be an unbiased estimate of ψ_t (that is, let $\sum_{-l}^{l} w_x \psi_x = \psi_t$), and let $y_t - \psi_t = e_t$, the error in the estimate. Then the expected value of e_t^2 is $\sigma_\epsilon^2 \sum_{-l}^{l} w_x^2$. This is minimum when $\sum w_x^2$ is minimum. Hence, the unbiased linear estimate of ψ_t with minimum mean square error can be found by minimizing $\sum w_x^2$, with the necessary and sufficient conditions imposed to make $\sum w_x \psi_x = \psi_t$.

The proof[9] of the principle that the least squares solution is the unbiased linear estimate with minimum mean square error does not seem sufficiently general to cover cases where the fitted function includes seasonal differences as parameters—that is, cases where the equations obtained by partial differentiation of the sum of the squared residuals can not be solved by the method of determinants. It may be remarked, however, that as a criterion for solving most problems, minimum mean square error would appear to be at least as good as minimum mean square residual. The technique developed informally in the following paragraphs by using the mean square error criterion has led to solutions

[8] See Whittaker, E. T., and Robinson, G., *The Calculus of Observations*, 1924, pp. 291–299; Sasuly, M., *Trend Analysis of Statistics*, 1934, p. 46; Tintner, G., *The Variate Difference Method*, 1940, pp. 100–105.

[9] See Whittaker and Robinson, *op. cit.*, pp. 215–231.

identical with the least squares solutions in the few cases where comparisons have been worked out.

First, compute a p-term moving total of the Y's. This results in a new series of observational values containing $n-p+1$ terms, $p-1$ terms being lost in the totaling procedure. This loss is offset by the elimination of p unknowns—namely, the p seasonal differences—which are equivalent to $p-1$ parameters because of the specification that their sum be zero. This new series contains all the parameters of the trend. Let one of the moving totals be represented by the expression

$$M_X = \sum_{x=X-h}^{X+h} Y_x$$

where $h=\frac{1}{2}(p-1)$. Let the estimated trend at the ordinate $x=t$ be written

$$y_t = \sum_{-L}^{L} W_X M_X \tag{9}$$

where W_X is a weight to be applied to M_X, and $L=\frac{1}{2}(N-1)$, N being the number of moving totals (that is, $N=n-p+1$). Then y_t is equivalent to $\sum_{-l}^{l} w_x Y_x$ where w_x is a linear function of the W's; for example,

$$w_{-l} = W_{-L}$$
$$w_{-l+1} = W_{-L} + W_{-L+1}.$$

Now write

$$Z = \frac{1}{2}\sum_{-l}^{l} w_x^2 + \lambda_0\left(\sum_{-l}^{l} w_x - 1\right) + \lambda_1\left(\sum_{-l}^{l} w_x x - t\right) + \cdots$$
$$+ \lambda_r\left(\sum_{-l}^{l} w_x x^r - t^r\right)$$

in terms of the W's, and set the partial derivative of Z with respect to each W and each λ equal to zero. Solve these equations simultaneously to find the values of the W's, and substitute in (9).

Assume, for example, that we are to find a set of W's to apply to 15 terms in a monthly series to estimate the linear trend at the point $x=t$. In this case, $r=1$, $p=12$, and $n=15$. Taking twelve-month moving totals of the Y's results in four totals: $M_{-1\frac{1}{2}}$, $M_{-\frac{1}{2}}$, $M_{\frac{1}{2}}$ and $M_{1\frac{1}{2}}$. From the relationship

$$\sum_{-l}^{l} w_x Y_x = \sum_{-L}^{L} W_X M_X$$

we have

$$\begin{aligned}
w_{-7} &= W_{-1\frac{1}{2}}, \\
w_{-6} &= W_{-1\frac{1}{2}} + W_{-\frac{1}{2}}, \\
w_{-5} &= W_{-1\frac{1}{2}} + W_{-\frac{1}{2}} + W_{\frac{1}{2}}, \\
w_x &= W_{-1\frac{1}{2}} + W_{-\frac{1}{2}} + W_{\frac{1}{2}} + W_{1\frac{1}{2}} \text{ for } -4 \leqq x \leqq 4, \\
w_5 &= W_{-\frac{1}{2}} + W_{\frac{1}{2}} + W_{1\frac{1}{2}}, \\
w_6 &= W_{\frac{1}{2}} + W_{1\frac{1}{2}}, \\
w_7 &= W_{1\frac{1}{2}}.
\end{aligned}$$

The function to be minimized is

$$Z = \frac{1}{2}\sum_{-7}^{7} w_x^2 + \lambda_0\left(\sum_{-7}^{7} w_x - 1\right) + \lambda_1\left(\sum_{-7}^{7} w_x x - t\right).$$

Replacing each w with the equivalent expression in the W's and setting the partial derivative of Z with respect to each W and each λ equal to zero yields

$$\begin{aligned}
12W_{-1\frac{1}{2}} + 11W_{-\frac{1}{2}} + 10W_{\frac{1}{2}} + 9W_{1\frac{1}{2}} + 12\lambda_0 - 18\lambda_1 &= 0 \\
11W_{-1\frac{1}{2}} + 12W_{-\frac{1}{2}} + 11W_{\frac{1}{2}} + 10W_{1\frac{1}{2}} + 12\lambda_0 - 6\lambda_1 &= 0 \\
10W_{-1\frac{1}{2}} + 11W_{-\frac{1}{2}} + 12W_{\frac{1}{2}} + 11W_{1\frac{1}{2}} + 12\lambda_0 + 6\lambda_1 &= 0 \\
9W_{-1\frac{1}{2}} + 10W_{-\frac{1}{2}} + 11W_{\frac{1}{2}} + 12W_{1\frac{1}{2}} + 12\lambda_0 + 18\lambda_1 &= 0 \\
12W_{-1\frac{1}{2}} + 12W_{-\frac{1}{2}} + 12W_{\frac{1}{2}} + 12W_{1\frac{1}{2}} &= 1 \\
-18W_{-1\frac{1}{2}} - 6W_{-\frac{1}{2}} + 6W_{\frac{1}{2}} + 18W_{1\frac{1}{2}} &= t.
\end{aligned}$$

Eliminating λ_0 and λ_1 and then solving for the four W's results in the solution:

$$\begin{aligned}
W_{-1\frac{1}{2}} &= 1/24 - t/36. \\
W_{-\frac{1}{2}} &= 0. \\
W_{\frac{1}{2}} &= 0. \\
W_{1\frac{1}{2}} &= 1/24 + t/36.
\end{aligned}$$

Substituting these values of W in (9) yields an estimate of y_t identical with that obtained from (5) and (6). Variations in this technique that lead to the same result are possible.

As another example, consider the problem of fitting a third degree parabola to the same 15 terms as before. In this case, we have the four conditions:

$$\sum_{-7}^{7} w_x = 1,$$

$$\sum_{-7}^{7} w_x x = t,$$

$$\sum_{-7}^{7} w_x x^2 = t^2,$$

$$\sum_{-7}^{7} w_x x^3 = t^3.$$

Since there are but four moving totals, these conditions alone are sufficient to determine the weights. Substituting equivalent values of W_x in the four equations, we obtain

$$\begin{aligned} 12W_{-1\frac{1}{2}} + 12W_{-\frac{1}{2}} + 12W_{\frac{1}{2}} + 12W_{1\frac{1}{2}} &= 1, \\ -18W_{-1\frac{1}{2}} - 6W_{-\frac{1}{2}} + 6W_{\frac{1}{2}} + 18W_{1\frac{1}{2}} &= t, \\ 170W_{-1\frac{1}{2}} + 146W_{-\frac{1}{2}} + 146W_{\frac{1}{2}} + 170W_{1\frac{1}{2}} &= t^2, \\ -648W_{-1\frac{1}{2}} - 216W_{-\frac{1}{2}} + 216W_{\frac{1}{2}} + 648W_{1\frac{1}{2}} &= t^3. \end{aligned}$$

The solution is

$$\begin{aligned} W_{-1\frac{1}{2}} &= -\frac{73}{288} + \frac{t}{2} + \frac{t^2}{48} - \frac{t^3}{72}, \\ W_{-\frac{1}{2}} &= \frac{85}{288} - \frac{19t}{12} - \frac{t^2}{48} + \frac{t^3}{24}, \\ W_{\frac{1}{2}} &= \frac{85}{288} + \frac{19t}{12} - \frac{t^2}{48} - \frac{t^3}{24}, \\ W_{1\frac{1}{2}} &= -\frac{73}{288} - \frac{t}{2} + \frac{t^2}{48} + \frac{t^3}{72}. \end{aligned}$$

If these weights are used to compute the y's and (3) is used to compute the k's, the residuals $y_x + k_i - Y_x$ in this example will all be zero. This is to be expected, since $n-(r+p)=0$.

The weights may also be written in the more general form

$$W_X = \frac{F_{(0,X)}}{24} + \frac{F_{(1,X)}}{36}t + \frac{F_{(2,X)}}{48}\left(t^2 - \frac{85}{6}\right) + \frac{F_{(3,X)}}{72}(t^3 - 38t) \qquad (10)$$

where the F's take the following values:

X	$F_{(0,X)}$	$F_{(1,X)}$	$F_{(2,X)}$	$F_{(3,X)}$
$-1\frac{1}{2}$	1	−1	1	−1
$-\frac{1}{2}$	0	0	−1	3
$\frac{1}{2}$	0	0	−1	−3
$1\frac{1}{2}$	1	1	1	1

By substituting in (9), we obtain

$$y_t = \frac{\sum F_{(0,X)}M_X}{24} + \frac{\sum F_{(1,X)}M_X}{36}t + \frac{\sum F_{(2,X)}M_X}{48}\left(t^2 - \frac{85}{6}\right) + \frac{\sum F_{(3,X)}M_X}{72}(t^3 - 38t).$$

Hence,

$$y_x = A_0H_0/D_0 + A_1H_1/D_1 + A_2H_2/D_2 + A_3H_3/D_3 \qquad (11)$$

where

$$\begin{aligned} A_0 &= \sum F_{(0,X)}M_X, & H_0 &= 1, & D_0 &= 24, \\ A_1 &= \sum F_{(1,X)}M_X, & H_1 &= x, & D_1 &= 36, \\ A_2 &= \sum F_{(2,X)}M_X, & H_2 &= x^2 - 85/6, & D_2 &= 48, \\ A_3 &= \sum F_{(3,X)}M_X, & H_3 &= x^3 - 38x, & D_3 &= 72. \end{aligned}$$

Expressing y_x in the form shown in (11) is convenient because the terms are independent; that is, the formula for the least squares polynomial of r degree is

$$y_x = \sum_{i=0}^{r} A_i H_i/D_i,$$

A_i, H_i, and D_i being independent of r. Hence, after a polynomial of r degree has been fitted to the data, a polynomial of $r+1$ degree may easily be fitted without recomputing the coefficients already found. In this respect, (11) is like (7); but (7) is suitable only for fitting trends to nonseasonal data; or from another viewpoint, (7) is the formula for the special case when $p=1$. Note, also, that $F_{(2,X)}$ is not orthogonal to $F_{(0,X)}$, and $F_{(3,X)}$ is not orthogonal to $F_{(1,X)}$; that is $\sum F_{(0,X)}F_{(2,X)} \neq 0$, and $\sum F_{(1,X)}F_{(3,X)} \neq 0$.

The problem of fitting trends to seasonal data might be simplified if extensive tables of F, H, and D were computed and made generally available.

The minimum mean square error principle can be used to compute weights for graduating seasonal data with moving arcs. By substituting 0 for t in (10), or in each of the four equations preceding, we obtain

$$W_{-1\frac{1}{2}} = W_{1\frac{1}{2}} = -73/288,$$

and

$$W_{-\frac{1}{2}} = W_{\frac{1}{2}} = 85/288.$$

These weights may be used to find the midordinate of a second or third degree parabola fitted to 15 terms in a monthly series. The weights can also be obtained directly by minimizing

$$Z = \sum_{-l}^{l} w_x^2 + \lambda_0\left(\sum_{-l}^{l} w_x - 1\right) + \lambda_2\left(\sum_{-l}^{l} w_x x^2\right),$$

the odd-numbered λ's and all powers of t (above zero) dropping out of the function to be minimized. The solution is simplified somewhat by the symmetry of the weights.

Table I shows the weights for fitting moving arcs of the second or third degree to monthly data. The operators are surprisingly simple. The table includes a line to show the ratio of the standard error of y_0 to σ_ϵ when the ϵ's are random selections from a universe with mean zero. This is computed by finding the square root of $\sum w^2$. It affords some measure of the smoothing power of the weights, being comparable with $1/\sqrt{n}$ for the arithmetic mean, which is .289 for $n=12$.

When one has computed the W's to apply to the moving totals in estimating the trend at any particular ordinate, the equivalent w's can readily be found by substituting values. An alternative method is to take a p-term moving total of the W's with $p-1$ zeros at either end of the W-series. If a large number of interpolations is to be computed by the use of punch cards and Hollerith machines, it may be more convenient to apply these w's to the original data than to apply the W's to moving totals. In other situations, the computations will probably be simpler with the W's.

It should be understood that the purpose of this article is to suggest techniques and not to advocate their use without discrimination. If the seasonal variations are multiplicative, rather than additive, the techniques that have been described may not be appropriate. True, the multiplicative variations can be transformed into additive variations by simply taking logarithms of the original series; but in careful work, the procedure should not be governed by mere convenience. The best

results are to be expected when the data are in such form, or have been put in such form, that they behave as though the deviations from the function whose parameters one is trying to estimate (not to be confused with the residual differences from the fitted function) were independent, homoscedastic, and normally distributed.

A METHOD FOR DETERMINING THE SIGNIFICANCE OF A SHORTAGE

By Lila F. Knudsen*
Food and Drug Administration

The method given here for making quick decisions with regard to shortages in weight utilizes the range of a sample. There are occasions confronting the practical person where a choice has to be made between a rapid utilization of statistical methods or none at all. The method suggested here attempts to fill this need for simplicity and rapidity of application and can be used in any question of shortage—not necessarily weight only—but any suspected deviation from a standard or specification. This is a criterion for the average. There are other criteria to be considered—e.g. criteria dealing with single units in the sample—but these are not discussed here.

Suppose we are given a sample of several units from a lot having a definite declared weight; the actual weight of each unit is observed, whence the average weight and range of the sample can be easily computed. The question is "Shall we regard this lot as having the weight declared, or as having a definite shortage in weight?"

THE METHOD

Rule: Take the shortage in weight, and the range between the smallest and largest weights in the sample tested, and perform the simple division:

$$\frac{\text{shortage in weight}}{\text{range in sample}}.$$

Compare this ratio with the figures in the table corresponding to the number of units weighed (size of sample). (i) If the calculated value of this fraction is less than the value in Column A, the presumption is that no shortage exists. (ii) If this fraction lies between the entries shown in the two columns A and B of the table, shortage is suspected and additional units should be weighed. (iii) If the fraction is greater than the value in column B, the presumption is that a definite shortage exists.

* The author wishes to acknowledge gratefully the continued assistance and encouragement given by Dr. W. Edwards Deming of the Bureau of the Budget.

DERIVATION OF THE METHOD AND COMPUTATION OF TABLE I

Let

D = declared net weight
$\bar{x}$ = average net weight of sample
$\sigma_{\bar{x}}$ = estimated standard error of $\bar{x}$

Student's t is defined as

$$t = \frac{D - \bar{x}}{\sigma_{\bar{x}}}$$

where

$$\sigma_{\bar{x}} = \sigma/\sqrt{N}.$$

$\sigma_{\bar{x}}$ is the standard error of the average weight $\bar{x}$ of a sample of N units (estimated from the sample), and σ is the estimated standard error of single observations. The range of the sample can be introduced into the formula for t by noting that the average range in a sample of N is a multiple S of σ. The equation

$$\max - \min = \text{range} = S\sigma$$

will then be true on the average.[1] By replacing $\sigma_{\bar{x}}$ by $(\max - \min)/S$, the formula for t can be rewritten as

$$\frac{t}{S\sqrt{N}} = \frac{D - \bar{x}}{\max - \min} = \frac{\text{shortage in weight}}{\text{range in weight}}.$$

Values of

$$\frac{t}{S\sqrt{N}}$$

are tabulated for various values of N in the table; they were calculated from the values of t that correspond to the two probability levels $P = .05$ in Column A, and $P = .001$ in Column B. These are approximations to the theoretical probability levels of the ratio (shortage in weight)/(range in weight).

A comparison of these tables with the A_2 values given on page 40 of the 1942 American War Standard (Ref. 2) shows that A_2 comes from a normal distribution while $t/S\sqrt{N}$ comes from the t distribution, the relation being

$$A_2 = (\text{normal deviate})/S\sqrt{N}.$$

[1] Values of S are available in Ref. 4, p. 165, or Ref. 8, p. 386, or as d_2 in Ref. 2.

TEST OF SIGNIFICANCE OF SHORTAGES

$$\text{Ratio} = \frac{\text{Shortage}}{\text{Range}}$$

N	A	B
3	1.468	10.777
4	.773	3.143
5	.534	1.655
6	.414	1.105
7	.342	.833
8	.294	.671
9	.259	.566
10	.232	.491
11	.212	.436
12	.195	.393
13	.181	.359
14	.169	.331
15	.160	.308
16	.151	.288
17	.143	.271
18	.137	.257
19	.131	.244
20	.125	.232
21	.120	.222
22	.116	.213
23	.112	.205
24	.108	.197
25	.105	.191
30	.091	.164
40	.074	.130
60	.056	.096
120	.035	.060
500	.015	.025

DISCUSSION

In any rule for coming to decisions, two types of mistakes may be encountered and are to be expected once in a while: either (i) a lot is accepted as passing a standard when further tests would not pass it; or (ii) a lot is rejected as not passing when further tests would pass it. The rule given here avoids these mistakes more successfully than any other workable scheme yet devised. Nevertheless, one can expect to make these mistakes once in a while.

As Simon (6) p. 115 quotes from Epictetus' "Discourses":

> Appearances to the mind are of four kinds. Things either are what they appear to be; or they neither are, nor appear to be; or they are, and do not appear to be; or they are not, and yet appear to be. Rightly to aim in all these cases is the wise man's task.

Here our "appearances to the mind" are the rules for coming to a decision, and Epictetus' last two kinds are the two types of mistakes we

encounter. We are not worried about the instances where appearances and reality agree. A rule for coming to a decision attempts to make the appearance of things agree with reality more often than not. It is imperative to consider the consequences of the two types of mistakes and decide where to draw the borderline between them.

When the sampling is not random but merely representative, as is usually the case, there are no theoretical objections to the use of the range. However, even the theoretical discussions of the range of a random sample are on the whole very favorable toward its use (1) (4) (7) (8) and date back to the first part of the twentieth century. The range is very sensitive and its use in quality control work has had excellent success (2) (3) (5) (6).

APPLICATION

The following example illustrates the application of the method. A sample of 12 jars of peanut butter is taken from a lot. Each jar is labeled "8 oz. net weight." The individual net weights as taken are (in ounces):

8.2	7.7	7.5
8.0	7.5	7.4
7.6	7.3	7.5
7.6	7.4	8.0

The average of the 12 jars is 7.64 ounces, and the range in weight is $8.2-7.3=.9$. Applying the rule, we obtain

$$\frac{\text{shortage in weight}}{\text{range in sample}}=\frac{8.00-7.64}{.9}=.400.$$

This value is larger than the value .393 in the table for $N=12$, therefore a definite shortage in weight is presumed.

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PAUL T. CHERINGTON, 1876–1943

PAUL T. CHERINGTON died in Philadelphia on the evening of April 24, 1943. That very morning in Washington he had participated in the deliberations of the Census Advisory Committee, a small committee of the American Statistical Association of which he had long been a member. The previous day had been spent by the same small group discussing the relationship of the Census Bureau to the statistical requirements of post-war planning. Overnight, Cherington evidently thought further about the problem. Immediately upon the opening of the meeting the following morning, he spoke for about fifteen minutes most sincerely and emphatically, voicing his profound concern with reference to the short-sightedness of business and government, the lip-service being given to post-war planning but the failure to reduce generalizations to the specific, and the essential requirements of statistical information on a national scale for adequate preparedness for the post-war period. It is a tragedy that these "last words" were not formally recorded as a living monument to his social vision. Characteristically, he was looking forward, working constructively to reduce broad social objectives to specific and practical terms.

Cherington always was a pioneer. He was among the first to recognize that marketing might be an area of recorded knowledge and his early teaching as a member of the original faculty of the Harvard Graduate School of Business Administration was to develop a systematic approach to marketing research. He later gave a practical demonstration of his thesis as Director of Research for the J. Walter Thompson Advertising Agency from 1922 to 1931. When the American Marketing Association was formed in 1931, he was the obvious choice for its first president. He founded the "Fortune" survey of public opinion, the pioneer enterprise in that presently well cultivated field. He was among the small group which fought for the so-called Census of Business in 1920, and spent endless hours in endeavors to increase its use and expand its usefulness. Additional items from his record would serve only to confirm the effectiveness of his creative pioneering. Nor can the complete record be found in his own activities. How many fires in other people were lit by sparks which he dropped, can never be known. But his friendliness, generosity and sincerity led to an enormous circle of friends and acquaintances who will always remember him with respect and affection.

In 1923, he drew up his specifications for a "successful life." And now it serves as a perfect summary of his own existence:

A successful life I should define as one which has brought a maximum of what have been called "durable satisfactions." Just what these are depends greatly on the individual. Measured by accepted social standards they would include a reasonable degree of personal comfort for one's self and his dependents, a sense of having lived helpfully with other people and a consciousness of having done something useful in the world which otherwise might not have been done. The surest aids to these accomplishments are an inquiring mind, clear thinking, an alert human sympathy, a lively sense of moral responsibility and a determination to work with those forces in the world which "make for righteousness."

WILLARD L. THORP

BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Studies in the National Income, 1924–1938, edited by A. L. Bowley. Cambridge: University Press. 1943. ix, 255 pp. $3.50.

This volume is the result of a study initiated in 1938 under the auspices of the National Institute of Economic and Social Research. Professor Bowley was Director of the investigation and, although others were associated with him on the project, he takes full responsibility for the methods followed and the opinions expressed. The outbreak of war forced curtailment of the original program and, as work cannot be resumed in the immediate future, the results obtained to date are being issued. While it is unfortunate that the intended plan could not be realized, the work as it stands is a major contribution to national income literature.

The volume consists of four chapters: The Definition of National Income; Some Constituents of the National Income; The Census of Production; Price Movements: Index of Real Income.

The chapter on definition by Dr. L. J. Elsas is a survey of the definitions used by the principal authors in the field, including the official estimates of those countries which issue national income data. The procedure used is to set up a comprehensive list of questions covering alternative concepts for the components of national income, and then to state the answers to the questions given in the works of the authorities listed. Thus, in highly condensed form one can see the degree of agreement among the twenty-four leading authors (including official estimates). It might be added that the questions answered for the principal authors are only those explicitly contained in their published works. An additional step might have been to indicate the answers to some of the questions implicit in the sources, contents, and procedures used by the authors, even though the questions were not formally discussed by them.

In the second chapter, Professor Bowley's paper from the *Journal of the Royal Statistical Society*, 1940, Part IV, is reprinted with some minor changes. This paper contains his estimates of national income for the period 1924–38. In general, it appears that Professor Bowley has adhered to the procedures he used with Lord Stamp in their estimate for 1924; his new results do not differ significantly from those of the earlier study for that particular year. A most useful addition to the *Journal* article made in this volume is a reconciliation of his national income aggregate for 1938 with that presented in the White Papers on war finance. As a consequence the projection of the White Paper estimates backward to 1924 by means of Professor Bowley's figures for the intervening years can be done much more confidently.

Further in the chapter Professor Bowley attempts a reconciliation of the labor force statistics of the Census of Population with the unemployment

and insurance records. It will be recalled that it was largely through reliance upon the latter that Mr. Colin Clark arrived at a national income figure for 1924 differing from that of Bowley-Stamp (apart from differences of definition). The apparent conclusion of Professor Bowley here is that the unemployment insurance records present no evidence strong enough to induce him to alter his estimate derived from the Census of Population data. His analysis seems to indicate, in any event, that the differences between the two sources are not great. The reviewer must confess that his knowledge of the sources is far from intimate enough to warrant any judgment on the matter.

In the third chapter, Professor Bowley discusses the estimation of national income from production data. He starts with the estimate of Mr. Flux for the year 1924 and shows that, after comparability has been achieved, the result reconciles favorably with his own estimate derived by the summation of income method. Throughout the second and third chapters the technical excellence which one associates with Professor Bowley's name is everywhere in evidence. The reader is not only presented with results but is led through the appraisal of alternative sources and methods, and is shown the evidence for the leading assumptions adopted. One is always conscious of the meticulous attention to detail and of the balanced judgment that lies behind the final result. The one serious limitation of the study is that it is directed toward establishing the correct total for national income to the neglect of the breakdowns required for economic analysis. Of course, this may be due to the interruption of the work by the war.

The index of real income presented in Chapter IV constitutes the most novel departure in the volume. In addition to one derived from income totals deflated by a price index, as is customary, Professor Bowley has attempted a quantity index from various quantity series directly. While this method must seem like the green fields that lie beyond to anyone who has struggled with inadequate price data, it soon becomes apparent that it is no less question-begging than the customary procedure. In the absence of quantity data for much of services output, for example, Professor Bowley uses employment to measure changes over time, assuming that output per head of employed persons remained unchanged for the period 1924–38. This is equivalent to saying that the increase in efficiency was equal to the decrease in hours worked. While the reviewer cannot speak of the plausibility of that assumption for Great Britain, the result of the method would considerably understate the increase of services output in the United States. However, the difficulties involved are more deep-rooted. For insofar as services are intermediate products (transportation, retail trade, etc.) it is difficult to see how the change in number of persons employed has any relevance whatsoever. Yet, when quantity indexes for goods and for services are combined by means of "value added" weights in the base year, such intermediate products must influence the aggregate quantity index which is designed to measure changes solely in the output of final products. If the economy has,

let us say, learned to economize on raw materials transportation, that is no reason why a given increase in the quantity of commodities reaching consumers should, in effect, be adjusted downward when the change in the latter is the object of measurement. Once it is recognized that only final product services can be included in the services indexes, the entire method loses much of its attractiveness.

The book contains much other interesting material which has not been touched upon in this brief review.

Milton Gilbert

Bureau of Foreign and Domestic Commerce

Income Size Distributions in the United States, Part I. New York: National Bureau of Economic Research, by the Conference on Research in Income and Wealth. 1943. xxvi, 131 pp. $1.00.

In 1938 the Conference on Research on Income and Wealth appointed a committee, under the chairmanship of Milton Friedman, to prepare a critical summary of recent significant studies of personal income distribution. The proposed study was to be an analysis of the limitations of data and methodology and was expected to serve as a basis for coordinating future studies. The present volume constitutes the committee's summary of findings and recommendations. Anyone engaged in appraising the results of past studies or in planning future studies will find this report indispensable.

The critical review is introduced by a chapter on "The Why and How of Distributions of Income by Size" by Simon Kuznets. This chapter discusses in general terms the reasons for preparing income distributions: the relationship of size of the recipient's income to his spending of it, the bearing of size of income upon the recipient's activities and attitudes, and the factors determining income size distribution. The discussion, while concerned primarily with demonstrating the necessity of varying the concepts of income, recipient unit, and time period in accordance with the specific purpose of each investigation, also stresses the importance of planning each inquiry to achieve comparability among studies. Only in this way can there be a full exploitation of limited data.

The committee illustrates the general remarks of the introductory chapter by analyses of 16 important studies. The summaries in Part I have been adapted from very detailed studies which appear in Part II, available only in mimeographed form. A convenient tabular summary sets forth for each study the period covered, geographic coverage, population groups to which the income data apply, and the nature of the income data. A similar summary is provided for the definitions of the family unit, types of income, and types of receipts.

An analysis of the major shortcomings of these studies provides the basis of recommendations for cooperative action in future studies. Without attempting to force income data collected for a variety of purposes into a

straight-jacket, the report urges a minimum degree of standardization and presents a reasonable outline for achieving it. The core of its recommendation is that an income concept for a particular purpose be devised and the tabulations planned so that comparisons can be made with a "standard" concept which is defined by the committee in considerable detail. In this manner a bridge would be erected linking future studies.

DANIEL CREAMER

Bureau of Foreign and Domestic Commerce

The Impact of Federal Taxes, by Roswell Magill. New York: Columbia University Press. 1943. ix, 218 pp. $3.00.

Professor Magill's lively volume makes its major contribution in three informative chapters on the impact of the tax law upon various forms of property disposition. Also, there is a useful sketch of the judicial history of Federal taxation in the thirties and a suggestive survey of the workings of the Bureau of Internal Revenue. The high competency of the author is evident as long as the discussion moves on the legal and administrative plane. Unfortunately, however, the more technical chapters are preceded by a general appraisal of the Federal tax system during and after the war, the level of which falls far below the standard set in the remainder of the book.

The chapters on the personal income tax, the estate tax, and the corporate income tax present an excellent survey of the impact of the statutes and their judicial interpretation upon various types of property settlements. Extensive reference to court decisions is made and will prove helpful to readers unfamiliar with the legal phases of taxation. The author's proposals for changes in the statutes are generally sound and would make for more equitable taxation. Thus, Professor Magill favors the taxing of Government securities and elimination of the advantages enjoyed by taxpayers in community property states under the Federal Income Tax. He emphasizes the tax advantage obtained by splitting the ownership of income earning assets. While there is no definite conclusion with respect to mandatory joint returns, the indications are that the author would be in their favor. The lack of correlation between the Federal estate and gift taxes is justly criticized. In their place a Federal tax on transfer is proposed which would cover inter vivos as well as testamentary transfers, with rates depending upon the amount of property received and the relationship of the recipient to the transferor. Accepting the conduit theory of corporate taxation, Professor Magill suggests that double taxation of dividends be eliminated by giving a credit to the corporation for personal income tax payment on dividends or vice versa. The importance of the tax structure with respect to corporate organization is emphasized in the conclusion that "the character of corporate structure has been more largely determined for some years by the tax provisions than by the industry of the anti-trust division of the Department of Justice."

In his technical chapters Professor Magill demonstrates the importance of the statutory and judicial phases of taxation for a realistic understanding of tax policy. The reader trained in economics will be startled to find, however, how little understanding of the broader economic aspects of taxation is evidenced in the first chapter of the book. The discussion in this chapter suffers from a complete failure to distinguish between the economic setting of taxation during the war and in the postwar economy. Although individual taxes are considered largely with reference to the war economy, Professor Magill on the very same basis somehow arrives at a proposed Federal tax budget for the postwar period. Of the total yield of $20 billion, $6.6 billion are to be derived from sales taxes including a general sales tax of 5 per cent and $8 billion are to be derived from the individual income tax, featuring a normal rate of 25 per cent and substantially reduced exemptions! Whatever the merits of this tax system for the war budget, it could hardly be acceptable for the postwar economy.

Economists may at times be guilty of disregarding some of the finer legal or administrative points of tax policy. But it is equally evident that tax policy in its broad outlines must first of all be based on an understanding of the *economic* issues involved. To this reviewer, the chasm between the legal-administrative and the economic training in tax problems appears most unfortunate.

Richard A. Musgrave

Washington, D. C.

Tax Yields: 1941. Philadelphia: Tax Institute, University of Pennsylvania. 1942. xi, 171 pp. $2.50.

This is the fifth volume of an annual series. The data include a survey of Federal tax collections for each of the years from 1913 to 1942. The annual tax collections of the states are presented for the years from 1938 to 1941. A monthly breakdown of state collection data is available for the first five months of 1941 and 1942.

Such a compilation is essential and necessary spadework. It is an important piece of groundwork which can serve as a starting point for a number of research projects. It would have been interesting to see a comparison of collections and expenditures. Revenue data alone are economically not very meaningful *per se*, although they are useful supplementary information. As the author points out, the tax collection figures alone do not give a comprehensive impression of the relative functional importance of state and local governments. Federal and state grants which are not listed in this volume, have increased during recent years. While the ratio of tax collections to national income is given for a period of thirty years, the reader misses a presentation of the revenue and expenditures ratio.

The data for the first five months of 1941 and 1942 can serve as clues for later war developments in tax collections in a limited way only. On one

hand, rationing has been felt on a larger scale in more recent months, thus influencing gasoline tax, sales tax, and various excise tax collections. On the other hand, the upward trend of prices continued, partly mitigating the reduction in collections due to rationing, at least as far as sales taxes are concerned.

On the whole, the book is most useful. It is reliable, well organized, and comprehensive within the limits set by the author. Moreover, no other book brings identical information.

The reviewer and many other economists appreciate the tedious and laborious task of Miss Mabel Walker who is responsible for these annual compilations.

HENRY SIMON BLOCH

University of Chicago

The Burden of British Taxation, by G. Findlay Shirras and L. Rostas. New York: The Macmillan Company. 1943. xiii, 240 pp. $3.00.

A statistical study of the burden of taxation is beset with many complications. Aside from the difficulty of obtaining exact data, there are various items for which estimates must be made and, if the real burden is to be envisaged, there is the elusive problem of the allocation of subsidies. Furthermore, what are the effects of governmental expenditures in general on taxpaying classes?

The purpose of the present study is to ascertain the money burden of taxation for the years 1937–38 and 1941–42 for a range of different incomes in Great Britain. The authors have brought forward with many additions and improvements the authoritative Report of the Colwyn Committee on National Debt and Taxation in 1927. Within the scope of the assumptions set and the limitations of data, the work is a model of statistical investigation. When it has been impossible to use exact figures, as for example, in computing the burden of indirect taxes, estimates have been made with painstaking care and discriminating judgment. The reader is fully warned with caveats in respect to the conclusions drawn from the analysis.

A taxpaying family of four (husband, wife and two children) with a single income, is selected as representative of the social family in England today, in contrast with a family of five in previous studies. The levels of income chosen range from £100 to £50,000. Approximately nine-tenths of all revenue of the Exchequer is included for 1937–38 and four-fifths for 1941–42, the main items of exclusion being business profits and rates on dwelling houses. In 1937–38 the distribution of the tax burden was not substantially different from that of the years following the first World War. Notable changes have come with the wartime program of taxation, particularly in the middle income groups. In prewar years, the distribution was markedly progressive in the upper range, e.g., £1000 and upwards, and was quite regressive on lower incomes of £300 or less. On middle incomes falling be-

tween these figures the burden was "light in comparison." The War burden is "notably" progressive on incomes above £250, and in the opinion of the authors is slightly more regressive on incomes below that amount. Direct taxes are now important on the middle income group and are very heavy for higher incomes. In the lower income range indirect taxes are much more significant. All in all the "increase in the taxation of income is the most striking development in British taxation and is nothing short of a revolution."

The method of computing the incidence of death duties in Chapter VI, was devised by Mr. N. Kaldor and is a departure from the traditional "insurance method." It is termed the "annuity" method and is used because of the impracticable nature of the insurance method for larger investment incomes. While criticism may be directed to the sweeping assumptions made by Mr. Kaldor, the results of his annuity method of computation appear plausible when viewed in the light of the extremely high income and surtax rates now in effect.

Tipton R. Snavely

University of Virginia

Fiscal Planning for Total War, by William L. Crum, John F. Fennelly, and Lawrence H. Seltzer. New York: National Bureau of Economic Research. 1942. xxv, 358 pp. $3.00.

Too much emphasis cannot be placed upon the principles of war financing in view of the magnitude and complexity of the problems encountered in financing our participation in World War II. While much water has run over the dam since this volume was written, it remains a significant analysis of the problems of financing a costly war with a minimum of inflationary effects in the most equitable and effective manner.

The authors present their analysis with reference to the fiscal year 1943. They assumed a gross national production of $125 or $130 billion and a net national income of approximately $113 billion. To cover Federal spending of $75 billion, a tax program to raise $40 billion was suggested. It was thought that some such sum would be required to limit borrowing to non-inflationary sources.

Three alternative tax programs are offered, the reader to take his choice of higher or lower corporate and personal income taxes, higher or lower excises, and a general sales tax if he wishes to place more emphasis upon consumption taxes. All of the programs call for $2 billion in new revenue from the social security taxes and $500 million additional from estate and gift taxes. Each of the programs would raise approximately $12 billion. To meet the goal of $40 billion, which the authors think desirable, another $10 billion would have to be found. Beyond hinting that even more severe tax rates would be required, the authors do not advance particular suggestions for new revenue except by implication as they appraise the various

available taxes. It is their purpose to indicate the rough outlines of a tax program adequate to obviate inflationary borrowing and to leave to the reader the privilege of deciding upon the specific taxes he would employ.

The tax program is combined with suggestions to cut at least $1 billion from nonwar expenditures and to exploit forced loans beyond the limits of voluntary loans and wisely selected taxes. The authors are careful to present the disadvantages as well as the advantages of each revenue proposal. Here may be found many of the essentials of a tax reform program as well as the requirements of a war taxing program.

The Federal tax receipts in the fiscal year 1943 actually fell far short of the $40 billion recommended. Only $23 billion were obtained from the gross tax and miscellaneous receipts, as compared with expenditures of some $78 billion.

The volume presents the results of a careful study of the principles and problems of war financing and is well worth reading by every student of public finance.

ALFRED G. BUEHLER

University of Pennsylvania

Accounts Receivable Financing, by Raymond J. Saulnier, and Neil H. Jacoby. New York: National Bureau of Economic Research. 1943. xv, 157 pp. $2.00.

This is an invaluable handbook for commercial banks, commercial finance companies, and factoring companies on the supply side of the business financing market and to concerns engaged in manufacturing, wholesaling, servicing, retailing, constructing, and mining on the demand side.

In its broader aspects this treatise is concerned with the cross-sectional pattern of business credit demands and the adaptations that financing institutions providing short and medium term credit have made in response to changing demands for their services.

This particular study deals almost exclusively with accounts receivable financing, although an attempt has been made to show how it is related to other financing methods. It is not concerned with instalment notes receivable, but rather with the process of "cashing receivables" by purchasing the invoices as well as other schemes relating to its title. It lives up to the statement by the authors that it is concerned with "the development and present quantitative importance of accounts receivable financing; the nature of institutions extending credit on this basis; the main features of the services offered by them; the chief characteristics of the businesses obtaining financial support from these agencies; the methods followed in conducting such financing; and the charges levied, income earned, costs of operation, and profitability of the business."

The authors have done a scholarly job of collecting data, treating it statistically and interpreting the results with a minimum of verbiage. State-

ments of fact are supported with adequate and clearly classified tables and in the appendix is a description of the procedures followed in getting the information. Throughout the book a careful distinction is kept between "factoring," which involves notification (non-recourse) and "non-notification financing," which is concerned with the purchase or assignment on a recourse basis.

Contrary to most books, the authors have placed a summary of their findings at the beginning rather than at the end, so that the reader has a prevue of what to expect.

I have only one minor criticism and that concerns the use of the term "net worth." We accountants are trying to steer clear of those misleading words, although they still appear in financial statements, texts, and other sources.

While this study contains much of interest for others, it should certainly be on the desk of all bank officials whose institutions in the future will be concerned with unused lending capacity. In it they will find a relatively new avenue of credit extension. It is a growing field and holds great promise for the future as it is being applied to an ever-widening range of industries.

Robert D. Ayars

University of Pittsburgh

Employment in Manufacturing, 1899–1939, by Solomon Fabricant. New York: National Bureau of Economic Research, Inc., 1942. xix, 362 pp. $3.00.

The present volume, a companion piece to the author's earlier volume on the output of manufacturing industries, 1899 to 1937, completes his statistical analysis of manufacturers from the turn of the present century to the inception of World War II. The problems and methods of measurement as well as the primary measures themselves are presented in a series of technical appendices that comprise half of the volume. The material presented in the body of the book is more aptly described by the volume's sub-title, *An Analysis of the Relation of Employment to the Volume of Production.*

Despite the fullness of the technical appendices, nowhere is there a discussion of the production index most appropriate for measuring output per unit of labor. Perhaps the omission stems from a realization that the character of the production index actually makes little difference, particularly over long periods of time, in view of the limited choice imposed by the available data. The appendices however, do more than merely set forth the statistical data underlying the author's analysis. Henceforth, all investigators faced with the formidable problem of achieving a comparable series from the Censuses of Manufactures between 1899 and 1939 will be indebted to Mr. Fabricant for his systematic and comprehensive presentation of the host of minor discontinuities that characterize the Census data.

In the body of the book Mr. Fabricant marshals in a lucid manner an imposing array of evidence to show convincingly (1) that "the industries

with particularly large increases in both employment and output between 1899 and 1937 tended to have exceptionally large declines in employment per unit, whereas those with under-average increases in both tended to reduce employment per unit less sharply than the average"; (2) that rapidly growing industries have characteristically "tended to effect particularly large reductions not only in labor per unit but also in wage costs per unit of product, in unit value added (that is, wage and overhead costs, including profits), and in selling price"—although why this has been characteristic of some industries and not others is not investigated; and (3) that "the largest increases in both jobs and output occurred in the major groups of manufacturing industries whose fixed assets, in terms of net book values, grew most rapidly [while] among the groups with relatively slight increases in output and employment are the industries with less-than-average increments to capital assets."

These are the major findings of statistical relationships. The chapter on the growth and decline of manufacturing industries largely confirms the earlier findings of Simon Kuznets and A. F. Burns on the retardation of growth. Such a summary, however, fails to do justice to Mr. Fabricant's careful workmanship and shrewd appraisal of the limitations of the underlying statistical materials and the deviations from the general pattern. He eschews the tempting path of easy generalization on the problems of technological unemployment. His discussion on this point emphasizes rather the inherent complexity of the interrelations of manufacturing with the other sectors of our economy. In this view an analysis of data on manufacturing alone cannot provide the answers to the problems posed by technological unemployment.

Compared with other investigations in the field the present study may be said, to its advantage, to steer a middle course. The work of the National Research Project,[1] for example, was given over entirely to the construction of measures designed to answer questions that are devoid of economic content. For example, how much employment would there be if we again attained the production levels of 1929? At the other extreme is the study of The Brookings Institution[2] which engages in an oversimplified analysis of the distribution of the benefits of productivity gains among the factors of production. The conclusions have little or no basis in the statistical materials. Mr. Fabricant, on the other hand, illuminates much more of the problem by concerning himself with relevant and meaningful relationships yet restricting himself to conclusions that can be demonstrated.

DANIEL CREAMER

Bureau of Foreign and Domestic Commerce

[1] *Production, Employment and Productivity in 59 Manufacturing Industries, 1919–36*, by Harry Magdoff, Irving H. Siegel, and Milton B. Davis, WPA National Research Project (May 1939).

[2] *Productivity, Wages, and National Income*, by Spurgeon Bell, The Brookings Institution (Washington, D. C. 1940).

The Measurement of Business Activity in the Puget Sound Area, by Grant I. Butterbaugh. Chicago: Studies in Business Administration, School of Business, University of Chicago. 1943. v, 72 pp. $1.00.

In his study, *The Measurement of Business Activity in the Puget Sound Area*, Professor Butterbaugh has presented a local index which shows monthly changes in business in an important industrial and trading region of the country. Dominated by the lumber industry and leaning heavily on foreign trade, the Puget Sound Area differs widely from other industrial sections in the United States.

As expected, the author was confronted with a scarcity of regional data. Moreover, most of the series which were available extended back only a relatively few years which reduces somewhat the confidence in the adjustments for seasonal changes and for trend. To throw more light on business changes in the region, however, a second index was constructed without adjustment for trend.

Some less desirable series had to be used in the index because more adequate data were not available. For example, factory employment was included in the production series as a partial measurement of production. Clearly, man-hours is a better indicator of production; but such data are not available for the area. Likewise, department store sales were used to reflect retail trade, whereas the addition of other types of retail stores would greatly enrich the series. But here again, data are lacking.

Perhaps the author goes a little too far in refinement, when he assigns weights in fractional points, such as 5.25 points to gasoline sales and 8.75 points to department store sales. And the assumption that gasoline sales in the Puget Sound Area follow the same pattern as the total for the state may or may not be valid, since the assumption disregards the factor of distance in the less densely populated sections.

The composite index should reflect changes in business in the Puget Sound Area, owing to the fact that it embraces production, shipping, trade, and finance. Extreme care was used in the selection of series in order to eliminate so far as possible duplications and at the same time to include sufficient data to reflect local conditions. It is true, of course, that business in any one region of the country follows a pattern more or less like that in the United States as a whole; but there are significant differences. Regional indexes are exceedingly helpful in understanding the over-all picture of business in the country, and the Puget Sound index is a welcome addition to the few now available.

Bervard Nichols

University of Pittsburgh

American Agriculture, 1899–1939: A Study of Output, Employment and Productivity, by Harold Barger and Hans H. Landsberg. New York: National Bureau of Economic Research. 1942. xxii, 440 pp. $3.00.

This book presents an intensive study of the annual volume of net agricultural output in the United States, by individual items and overall, of labor used in agriculture, of food consumption, and of farm productivity per acre and per man.

While the basic data are valuable, the analysis suffers from a number of weaknesses:

(1) The limitation to the period since 1899, and the general failure to take into account agricultural history prior to the 1900's.
(2) The use of linear trends without reference to whether they were adequate to represent the data.
(3) Lack of familiarity with public agricultural policy during the 1930's. With one minor exception, public policy is treated as a matter of A.A.A. restrictions, without recognition of the soil conservation emphasis since 1936, or its possible relation to subsequent increases in yields and output.
(4) Elaborate calculations of labor requirements for crop and livestock production (pp. 254–277) carried far beyond the significance of the basic data.

In the final chapter, the authors develop the thesis that the rapid secular increase in productivity per capita, both in agriculture and in industry, together with the relatively inelastic demand for food, forces a continuous reduction in the proportion of workers engaged in agriculture, and a resultant chronic depression in the relative economic position of farmers. C. Reinold Noyes, Director of the National Bureau, vigorously challenges these conclusions and their significance as a forecast for the future in an extensive dissent on pp. 316–321. He bases his dissent on the imperfections of analysis such as those noted above and especially on the failure to take into account the historical shift from pioneer settlement and expansion to a settled country. While the reviewer agrees with Noyes as to the weaknesses of the analysis, he still is inclined to agree with the general drift of the authors' conclusions, having reached parallel conclusions several years earlier on the basis of a superficial study covering a longer historical period.[1]

The book will be useful to research workers for its copious reference tables of the annual net output, prices, and consumption of individual farm products, for its new index numbers of net physical production, which take into account changes in farm livestock inventories, and for its careful canvass of the comparability of the available data on agricultural employment.

MORDECAI EZEKIEL

U. S. Department of Agriculture

[1] Mordecai Ezekiel, "Population and Unemployment," *The Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 230–242. Nov., 1936.

Western Prices before 1861, A Study of the Cincinnati Market, by Thomas Senior Berry. Cambridge: Harvard University Press, Harvard Economic Studies, 74. 1943. xxi, 645 pp. $5.00.

This excellent study sheds much light, not only upon the behavior of prices in the West and particularly in Cincinnati, but also upon the general pattern of economic life in Cincinnati and its tributary area. Attention is called to the long-term trends in the growth of the West and in the declining cost of manufactures and imported goods as compared with the values of exportable agricultural produce of the area. Improved transportation and better production techniques are emphasized. The behavior of markets and prices during the period when dependence was placed upon river transport is shown to differ from the more marked seasonal pattern prevailing at a later date when the railroad had become well developed. Moreover, stress is laid upon the influence of traffic development in determining the character of transport facilities.

Discussion of the salt trade leads to an interesting detailed account of the efforts of the saltmakers to limit production and control prices. The close relationship between the Kanawha salt companies and the later Michigan salt associations is pointed out as is the later borrowing of technical methods by the oil industry and the probability that technical methods were also transferred. This section lends more support to the theory that the combination movement after 1880 was but an extension of earlier and not unsuccessful attempts of similar nature.

In his survey of the cyclical behavior of prices, the author sheds much new light upon banking and currency in the West. Moreover, through a detailed examination of successive crises in a particular area he strengthens our grasp of the nature of these phenomena during the period under discussion. It is possible to view them less abstractly, not in terms of averages, but in the light of their impact upon the life of a particular area. Much attention is given to the note issue of the various financial institutions serving the area, the difficulties attending the use of paper currency, the stringency of specie, and the periodical tightness in the supply of New York exchange. The author advances for further investigation the interesting hypothesis that the relative value of any single issue of bank notes depended more upon the total amount of coin held in the issuing bank than upon the quantity of the notes in circulation.

The mass of detailed information drawn together from widely scattered sources is well organized and ably presented. The study is capped by a general summary and conclusions which bring together the major points in the analysis. It merits the attention of all economists concerned with the general range of problems treated.

Ernest W. Williams, Jr.

War Production Board

International Agreements on Conservation of Marine Resources, by Jozo Tomasevich. Stanford University: Food Research Institute. 1943. xi, 297 pp. $3.00.

The author conducts a critical examination of the problems involved in international conservation of marine resources and then follows with the history and development of international agreements to conserve and sustain the fisheries for three biologically different species, namely, fur seals, halibut, and sockeye salmon—all found in the North Pacific. At present the fisheries for the first two species are under international control and regulation while the third is undergoing intensive scientific study preparatory to regulation. The commodities resulting from the three fisheries differ greatly. The fur-seal herd supplies a valuable type of fur; the halibut fishery, a food fish sold exclusively in fresh or frozen state; and the sockeye-salmon fishery supplies a product marketed almost entirely in the canned form.

The underlying problems are grouped under three headings: (1) international law, (2) scientific research, and (3) conservation and systematic development and use of fisheries as such.

One of the defects requiring correction in the existing international agreements on fur seals, halibut, and sockeye salmon, as pointed out by the author, is that they still leave these fisheries open for invasion by "foreign" fishermen, that is by fishermen native to countries not a party to the agreement. These agreements seem to have recognized the old Roman law which regarded the sea as common domain, free for the use of all and its riches were *res nullius*—unappropriated goods. Property rights in the products of the seas could be established and kept only with actual possession.

The author believes that it will likely be necessary in the future to give more consideration to the economic and technological problems involved in the development of international fishery agreements. Thus far emphasis has been placed on the biological side. Many will agree with his belief since fishery enterprises are held in delicate economic balance and any controls which regulate the intensity, amount, time, and place of fishing may necessitate economic adjustments involving radical changes in fishing gear and vessels and involving an altered pattern of labor supply and prices. These aspects are analyzed and an evaluation is made of the effect of the different types of controls. The author also points out the difficulties experienced by each industry, especially the halibut industry, in adjusting its activities to conform with the controls.

Under the fur-seal agreement the fur-seal industry became a U. S. Government monopoly with the high contracting parties sharing in the proceeds as agreed in the convention. Under the halibut agreement the industry continued as a multitude of small enterprises, but largely limited to that group of fishermen which engaged in the fishery prior to its regulation and control by the halibut commission. As the reader considers the nature, aims, techniques, limitations, and achievements of the international agreements on

fisheries as set forth in the book, the question may arise in his mind as to whether these agreements—which are aimed at conserving, sustaining, and increasing supply for the public good—are of primary benefit to the interests engaged in the fishery enterprise, consumers of the product, or both.

There is no doubt but that government officials charged with the responsibility of drawing international fishery agreements, as well as fishery industrialists and students will find a wealth of interesting and useful material for reference and study in Dr. Tomasevich's well-written book.

Reginald H. Fiedler

Office of Foreign Economic Administration

Public Trusteeship, by Norman S. Heaney. Baltimore: John Hopkins Press. Studies in Historical and Political Science, Series LX, No. 4. 1942. 130 pp. $1.50.

This monograph explores in a very competent fashion a field of public enterprise so little known in the United States as probably to require some explanation. By public trusteeship Heaney refers to the performance by a government official of the trust function for private purposes as defined by English common law. Public trusteeship is thus typically a phenomenon of England and her colonies and dominions. Heaney's study is primarily an examination of the working of the office of the English Public Trustee, a government department which has been in continuous operation since 1908. One chapter, however, is devoted to experience with a similar institution in New Zealand, dating from 1872, which offers an interesting contrast to the English trustee in that a number of other fiduciary duties (serving as executor, administrator, guardian, receiver, liquidator, etc.) have been added to those of trusteeship.

So far as the English Public Trustee is concerned, Heaney traces the acceptance of the idea through a long period of consideration in Parliament, and then turns to a detailed analysis of the types and volume of business handled and an examination of practices—organizational, administrative, and investment—in the management of trusts. While there is no deliberate attempt to place the work of this agency against the larger background of British experience with other public enterprises, the information necessary for such a comparison is fully given. It appears that the original policy of the Trustee was a vigorous promotional one, which was assisted by an absence of serious competition from private corporate trustees. However, the office has more recently adopted a passive attitude, and Heaney believes that it is being choked off by private competitors. The staff of the Trustee was originally outside the Civil Service, but was later brought in over the objection of the Trustee, who feared the effect of this step on the competitive spirit of the agency. Fees charged are expected to cover the cost of the office, and have done so continuously since 1923. Comparison with the costs of private trustees is impossible, owing to absence of data on their operations.

In the concluding chapter of his thorough and scholarly study, Heaney examines the problems that would face a system of public trusteeship in the United States, which he regards as a "clear path to trust improvement" though not a "crying need."

C. HERMAN PRITCHETT

The University of Chicago

The Tragedy of European Labor, 1918–1939, by Adolf Sturmthal. New York: Columbia University Press. 1943. xii, 389 pp. $3.75.

As indicated by the title, Dr. Sturmthal has here presented a picture of the failures of organized labor in Europe between the two wars. That picture is excellent; calmly drawn, judiciously weighed, based upon reliable facts, and generally valuable. Students of history, political events, or of the labor movement, as well as labor leaders themselves can well afford to put time and thought into this comprehensive study.

The key to the whole study is the distinction between "pressure-group action and political activity"; and it is upon this basis that the author makes his penetrating examination of labor's history as a cultural phenomenon during more than twenty fateful years.

The first section of the study is devoted to giving the explanation for the failure of labor in terms of the criteria established by the author. That failure is seen as being a failure by European democracy to integrate social groups with their conflicting interests into a functioning industrial society. At this point labor, though strongly committed to the defense of democracy did not, or could not, stem the progressive disintegration of democracy. Thus the stage was set for the Fascist reintegration in terms of force.

Labor inherited the reins of government in many places after the first World War, but for several clearly illustrated reasons the various labor governments were unable to grow, as it were, with the needs of the era, and to provide the necessary political leadership. Labor, as a political party, was a pressure group because it did not make an effort to integrate its interests with those of the community of which it formed a part. Democracy could not prosper without the "active participation of labor," while labor, even when in power, was refusing its real responsibilities. The result, democracy fell, and with it went labor.

European labor, as a pressure group, was concerned only with a "narrow range of problems, namely those immediately affecting the interests of its membership." Thus, when in power, labor governments confined themselves to trades-union questions such as wages and hours, and did not bother to enter and influence the larger national and international issues upon which the fate of the continent rested.

Moreover, labor governments often relied upon traditionally conservative elements of pre-war society in utilizing the old civil service and the old Imperial army corps officers as props for the new democratic states. This was

particularly the case in the young German democracy when Rightist Free Corpsmen defended the Socialist government against striking workers.

A tragically "amusing" factor in the failure of labor at this time, also, was the spectacle of labor governments lending naive support to *laissez faire* doctrines because of their theoretical view that the dialectic of the inevitable downfall of capitalism demanded that no attempts be made to work within the existing economy to affect any peaceful changes. Thus labor viewed plans for shortening the depression with alarm on the grounds that depressions were an inevitable part of capitalistic economy and that nothing should be done until capitalism fell.

In his concluding chapter Dr. Sturmthal observes that, "the progress of labor from the status of pressure group to political party could succeed only to the extent that the masses themselves gained understanding of their own tasks. . . . Only improved insight into the situations confronting them could induce the workers to abandon their narrow trades-unionist outlook in favor of broad constructive policies which would serve both the entire nation and create the conditions necessary for labor's further social advance." Unfortunately the record as here presented shows that labor did not gain this insight, although the British Labor Party, in forming the coalition government of 1940, seems to give signs of a new, constructive approach.

One of the most useful phases of this book is the attention paid to the significance of the integration of the various elements of modern industrial society. The author has clearly grasped the need for organization in terms of the new functional interdependence of men. The story of European labor is a most powerful plea for the necessity of integrated thinking and mutually constructive action for common goals which must transcend national boundaries if men in any one land are to be free from want and fear.

Robert I. Crane

Washington, D. C.

Elementary Statistical Methods, by Helen M. Walker. New York: Henry Holt and Company, Inc. 1943. xxv, 368 pp. $2.75.

This is a text for a first-semester course in descriptive statistics for students who hope to conduct educational research or to read the literature on such research. The emphasis is on the development and understanding of ideas rather than on formulas and computational routines. At the same time the book is intended to serve as an introduction to the author's coming volume, *Statistical Inference*. The student is introduced to analysis of variance, the sampling distribution, and sampling problems as well as to averages, variability, frequency distribution, and simple correlation.

Well-chosen quotations and historical references which add to the interest of the book are frequently given. Mathematical notes and proofs of some of the formulas shown in the text are given in one of the five appendices where they may be more easily skipped by those not able to follow such discussions.

It is intended that the instructor will provide adequate drill material. The checking of problems worked out in table form in the book is suggested for practice. Moreover, a number of unusually good exercises are given throughout the book.

Beginning statistical workers who might expect this to be a reference book containing explanations of all the usual statistical techniques set forth in an elementary manner may be disappointed: the topics of partial and multiple correlation, measures of reliability, time series, and index numbers are not discussed. The list of formulas in the appendix are not especially adapted to ready reference since they are shown without names; nor are formulas for the standard deviation and the correlation coefficient shown in the forms best adapted to machine calculation.

A characteristic of the book which may be troublesome to beginning students is that statistical terms are used many pages before they are defined or explained.

The titles of the fifteen chapters, in order, are as follows: Orientation; The Nature of Measurement; The Frequency Distribution; The Presentation of Data in Tables; Measures of Relative Position; Symbolism in Statistics; Averages; Measures of Variability; The Mean and Standard Deviation under Various Circumstances; Further Characteristics of a Frequency Distribution; The Normal Distribution; Regression and Correlation—General Concepts; Regression and Correlation—Computations; Correlation and Regression—Interpretation; and Sample and Universe.

LAVERNE K. BURKE

Community Occupational Surveys, by Marguerite W. Zapoleon. Washington: U. S. Office of Education, Government Printing Office. 1942. vii, 199 pp. 25 cents.

This is a study of ninety-six surveys completed during the period 1930–40. Part I deals with such topics as the nature and history of surveys; then it takes up the preliminary research, planning the content, planning survey forms, community cooperation, training personnel, preparation of reports and results. Part II discusses in some detail twelve to fifteen of these surveys. The surveys that are covered in detail range from small and rural communities up to the occupational census of the United States for 1940. Many excellent comments are made on these particular surveys. Part III discusses the steps that should be taken in a community occupational survey. This section provides a very fine check list for anyone planning to study the occupations in a community. This outline of the steps taken should prove of great help in many situations.

This volume as a whole gives a very fine discussion of the survey techniques that are more commonly used. As this is all the volume claims to do, the following comments may not seem to be in order. On page 66 it is admitted that continuous surveys are really what we need. "What is needed,

then, is a popular demand to set that machinery in motion and to supply adequate personnel and materials with which to carry on a continuous inventory of labor supply." It would seem as though the study of all of these surveys would have suggested many techniques for carrying on this continuous survey even with the resources now available. It is the opinion of the reviewer that any community that wants to do so, if it is willing to use the young people in the school, can immediately start a continuous survey program and keep it up to date at all times. This is probably the most realistic way that occupational information can be brought to the young people of a community.

It should also be the best possible kind of civic training showing them the importance of the working life of their own community. Almost all of these surveys contain special suggestions of shortcuts and methods that would be of help to other communities. It might have led to a great improvement in the technique of making surveys if these could have been brought together in one place.

In addition to the main body of the report, there is a very valuable appendix giving an annotated bibliography of reports of community occupational surveys. There is another appendix giving the bibliography of community occupational surveys and there is a third appendix giving samples of the actual cards and records used in making surveys. This volume should play an important part in bringing closer the day when we will have continuous and up to date information regarding the occupational supply and demand in every community in the land.

Harold F. Clark

Columbia University

Mathematical Statistics, by S. S. Wilks. Princeton: Princeton University Press. 1943. xi, 284 pp. $3.75.

The study of Mathematical Statistics has been seriously hampered by the lack of good books and by the fact that many important developments of the theory can be found only in the original form and widely scattered in scientific periodicals. The author has performed a very valuable service to all interested in the field by writing the present excellent book. The content of the lithoprinted book is formed chiefly by the subject matter of a two-semester course given by the author for advanced undergraduate and beginning graduate students. As such it has, of course, its limitations. It was impossible to cover in great detail all important developments of the theory or to give very extensive illustrations. However, the book contains the basic material in a concise form and gives an excellent introduction to the more recent developments of the mathematical theory of statistics. At the end of the book a number of publications are listed which are recommended for supplementary reading. The book contains chapters on the following subjects: Distribution Functions, Some Special Distributions, Sampling Theory,

Sampling from a Normal Population, On the Theory of Statistical Estimation, Tests of Statistical Hypotheses, Normal Regression Theory, Applications of Normal Regression Theory to Analysis of Variance Problems, On Combinatorial Statistical Theory, and An Introduction to Multivariate Statistical Analysis.

The reader will particularly welcome the chapters on Combinatorial Statistical Theory and on Multivariate Statistical Analysis. These theories are of growing importance and substantial advances in them have been achieved recently. Unfortunately, the literature on these topics is widely scattered and not sufficiently well known. Although the presentation of this material is necessarily brief, the reader will find it exceedingly useful. In the discussion of problems of analysis of variance (Chapter IX) the author brings out clearly the fact that these problems can be considered as problems in regression theory, a fact which is not so generally known.

Readers with some mathematical background will find the book an excellent introduction to the modern developments in the theory of mathematical statistics. Also teachers of mathematical statistics will find it very helpful in their classroom work. The book can be highly recommended to everyone interested in this field.

ABRAHAM WALD

Columbia University

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CONTENTS OF VOLUME XIV, NUMBER 3, SEPTEMBER, 1943

The Comparison of Different Scales of Measurement for Experimental Results. W. G. Cochran 205

On Stochastic Limit and Order Relationships. H. B. Mann and A. Wald 217

On a Measure Problem Arising in the Theory of Non-Parametric Tests. Henry Scheffé 227

Further Results on Probabilities of a Finite Number of Events. Kai Lai Chung 234

On the Problem of Testing Hypotheses. R. v. Mises 238

On the Reliability of the Classical Chi-Square Test. E. J. Gumbel 253

A Sampling Inspection Plan for Continuous Production. H. F. Dodge 264

On the Theory of Runs with Some Applications to Quality Control. J. Wolfowitz 280

The Accuracy of Sampling Methods in Ecology. Paul G. Hoel 289

News and Notices 301

Report on the Washington Meeting of the Institute 302

Report on the First Meeting of the Pittsburgh Chapter of the Institute 303

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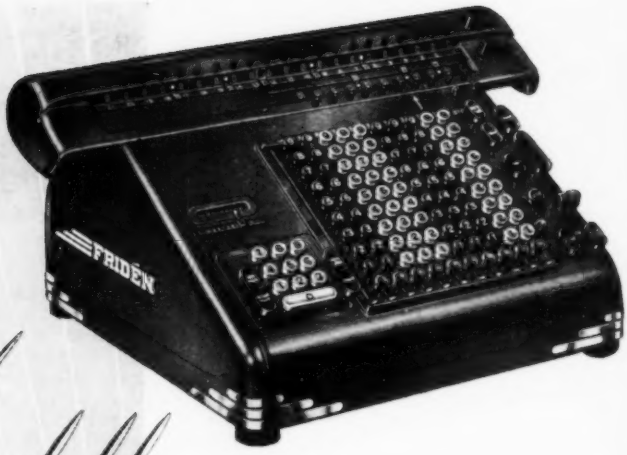

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